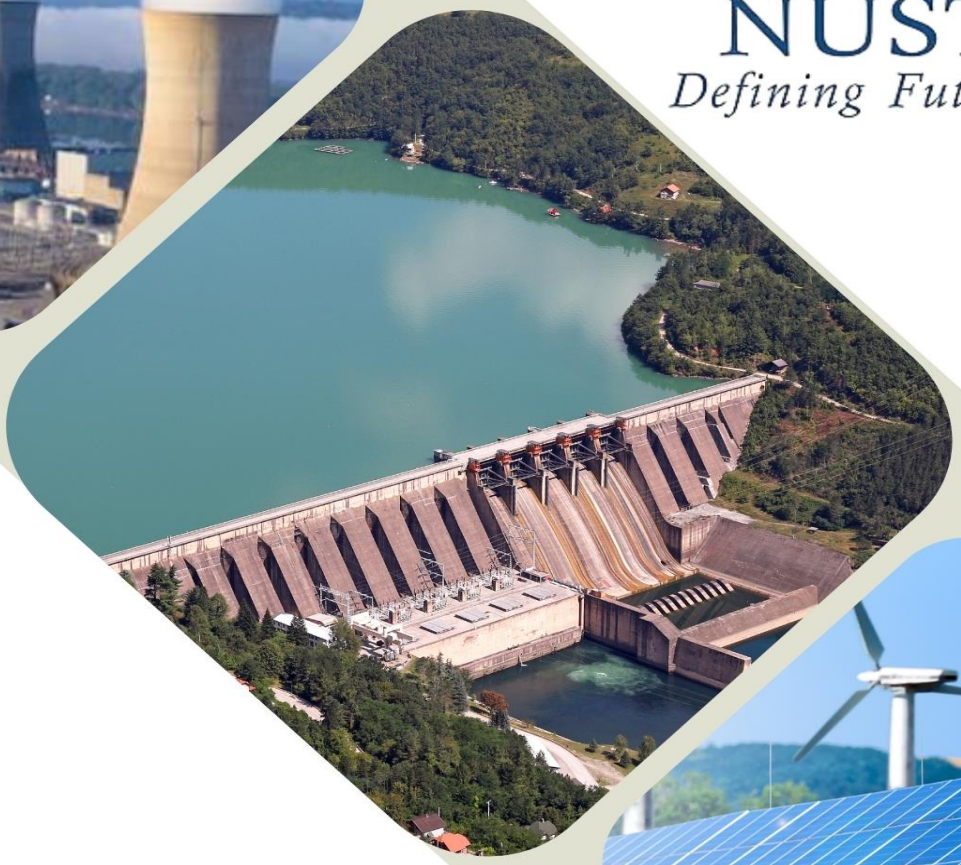

NUST
Defining Futures

PAKISTAN'S ENERGY SECTOR

ISSUES, CHALLENGES AND THE WAY FORWARD

NIPS
NUST INSTITUTE OF POLICY STUDIES

NUST
US-PAKISTAN CENTER FOR ADVANCED STUDIES IN ENERGY (USPCAS-E)

Report of the

National Seminar on

Pakistan's Energy Sector

Issues, Challenges, and the Way Forward

NUST Institute of Policy Studies (NIPS)

NUST | Islamabad

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Speakers

- Ms Veeraya (Kate) Somvongsiri, Mission Director, United States Agency for International Development (USAID), Pakistan.
- Mr. Muhammad Ali, Former Caretaker Federal Minister for Energy, Power & Petroleum.
- Mr. Noor Ul Arifeen Zuberi, Senior Advisor, China Three Georges South Asia Investment Ltd.
- Dr. Fiaz Ahmad Chaudhry, Professor and Werner-Von-Siemens Chair, Syed Babar Ali School of Science and Engineering.

Moderator

- Dr. Ashfaque Hasan Khan, Director General, NUST Institute of Policy Studies (NIPS).

Discussants

- Dr. Osman Hasan, Pro-Rector Academics, NUST.
- Ambassador Fauzia Nasreen, Former Ambassador of Pakistan to Nepal, Poland and Czech Republic.
- Dr. Amir Azam Khan, Principal, NUST School of Chemicals & Materials Engineering (SCME).
- Dr. Adeel Waqas, Principal, US-Pakistan Center for Advanced Studies in Energy, NUST.
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- NIPS Core Team.
- NUST Student


National Seminar

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About the Speakers

Ms Veeraya (Kate) Somvongsiri

Ms Somvongsiri is a career member of the Senior Foreign Service, assumed the role of Mission Director for USAID Pakistan in August 2023. Prior to this, she served as the Mission Director to Tanzania from 2021-23, Deputy Mission Director in Tanzania from 2019–21 and was Acting Deputy Assistant Administrator for USAID's Bureau of Democracy, Conflict, and Humanitarian Assistance from 2017–19. She has served as a Democracy, Rights and Governance Officer in Indonesia, Afghanistan, Ukraine, and Washington. Ms. Somvongsiri began her career with USAID in 2002 as a Presidential Management Fellow and joined the Foreign Service in 2006.

Mr. Muhammad Ali

Mr. Muhammad Ali served as the Caretaker Federal Minister at Ministry of Energy (Power Division). He has thirty years of domestic and international work experience in the public and private sectors, including as Chairman of the Securities and Exchange Commission of Pakistan.

He also Chaired the Committee on Power Sector Audit, Circular Debt Resolution and Future Roadmap which prepared a detailed report for reforming Pakistan's power sector, and was member of the negotiation team which successfully negotiated revised power tariff and signed the MoUs with private power producers.

Mr. Ali revamped the capital market and corporate governance landscape of Pakistan by ensuring successful passage and implementation of the Demutualization Act, 2012, and developing a revised capital gains tax regime.

He served on Boards of leading Pakistani corporates, stock exchange, credit rating agency, Capital Market Advisory Council, Federal Board of Revenues' Tax Advisory Group and Government of Pakistan's Economic Coordination Committee of the Cabinet. Moreover, he led the team advising the Government of Pakistan on IPOs of the largest Commercial bank and one of the largest E&P companies in the country.

Dr. Fiaz Ahmad Chaudhry

Dr. Chaudhry is an Electrical Engineer with over 34 years of experience in electric utility industry, consulting engineering and academic environments. He specializes in areas of energy policy, power system planning

and operation, restructuring of electric utilities, electricity markets, smart grid solutions, project, program and utility management. Prior to joining LUMS as Professor of Practice, he was MD, NTDC and held other senior management and practice lead positions in multiple electric utilities and two consulting engineering firms. He is founding Director of LUMS Energy Institute and also holds distinguished position of Siemens Verner-Von Chair. He supervises applied research projects for the electric utility industry and developing many technical and technology transfer courses for capacity building of professionals in Pakistan's Power Sector. He authored hundreds of technical reports and articles, given numerous technical talks and delivered keynote addresses and speeches internationally.

Mr. Noorul Arifeen Zuberi

Mr. Zuberi serves as a Senior Advisor for China Three Gorges South Asia Investment Limited (CSAIL), a subsidiary of China Three Gorges Corporation (CTG), a role he took on in 2015. In this capacity, he oversees the operations of China Three Gorges in Pakistan, which includes managing projects such as the 720 MW Karot, 1124 MW Kohala, and 640 MW Mahl Hydro Power Projects in AJK, as well as the 150 MW Wind Power Project. Notably, his

acumen and leadership were pivotal in commissioning the 720 MW Karot Hydro Power Project one year ahead of schedule on June 29, 2022, achieving significant cost savings.

With a robust career spanning over 45 years in the Power Sector of Pakistan, Mr. Zuberi has contributed significantly to prestigious institutions such as the National Engineering Services Pakistan (NESPAK), the Ministry of Planning & Development, and the Private Power Infrastructure Board (PPIB). Throughout his career, he has played a pivotal role in the development and implementation of various prestigious power projects.

Mr. Zuberi is a well-recognized repository of Independent Power Producer (IPP) knowledge in Pakistan. In recognition of his exceptional contributions, Mr. Zuberi was awarded the Outstanding Performance Employee by CTG in 2017.

1. Executive Summary

NUST's US-Pakistan Centre for Advanced Studies in Energy (USPCAS-E) in collaboration with the NUST Institute of Policy Studies (NIPS) organized the national seminar on Pakistan's energy sector issues, challenges, and the way forward on Thursday, May 16, 2024. Moderated by Dr Ashfaque Hasan Khan, DG NIPS, the seminar brought together leading energy experts and professionals, private sector representatives, and a large number of academics, scholars, researchers, and students.

The seminar's special guest, Mission Director USAID Pakistan, Madam Veeraya Kate Somvongsiri, was welcomed on arrival by Rector NUST, Lt. General Javed Mahmood Bukhari (Retd). Speaking at the occasion, USAID Mission Director appreciated the role of NUST in nation-building and highlighted that the U.S.-Pakistan cooperation was focused on stronger economy, better governance, and healthier and smarter people. Dr. Osman Hasan, Pro-Rector, Academics, NUST, in his opening remarks, emphasized the need for exploring affordable, resilient, viable, pro-people, and sustainable pathways to national energy futures.

One of the seminar's speakers, Dr. Fiaz Ahmed Chaudhry, Director, LUMS Energy Institute, underscored the need for energy efficiency and smart demand management to deal with the power shortfall as opposed to an exclusive focus on supply-side measures like increasing power generation capacity. Dr. Chaudhry proposed the

establishment of a national energy security council or a national energy commission as the apex body for dealing comprehensively with energy and power sector challenges.

Talking about the active role that the private sector could play in the development of the hydropower potential of Pakistan, Mr. N. A. Zuberi, Senior Advisor – CSAIL, highlighted that the unique and distinctive features of 750 MW Karot Hydropower Project, as a major private-sector success story, included the project's proximity to load centre, closeness to national grid requiring only 3 km of transmission line, no significant environmental impacts, and elaborate community development initiatives like hospitals, schools, bridges, roads, and engineering scholarships for the project area.

Highlighting the need for energy and power sector reforms, Mr. Muhammad Ali, former Caretaker Federal Minister for Energy, Power and Petroleum, proposed that the energy ministry needed to focus on policy and regulatory functions and devolve all other powers. He stressed the privatization of power transmission and distribution companies along with the unbundling of Sui companies coupled with greater private access to all parts of the energy and power supply chain to make commercially-driven and market-based solutions possible. The former caretaker energy minister stressed the need for the implementation of a robust supervisory, control and data acquisition system in the energy

sector consisting of well-head telemetric systems for gauging gas and crude oil reserves, on the one hand, and attracting investment for exploration and production of indigenous energy resources, on the other. The former minister also advocated the removal of all cross-subsidies and broadening the tax base to avoid burden on utilities to make things easy for common consumers.

In his closing remarks, Dr. Adeel Waqas, Principal, USPCAS-E, underscored NUST's commitment to pursuing high-quality innovative research, technology development, and human capital formation in energy science and engineering for sustainable national development.

2. Special Guest's Address

Ms Veeraya (Kate) Somvongsiri
Mission Director, USAID Pakistan

Ms Somvongsiri expressed pleasure in joining for the first time the NUST's national seminar on Pakistan's energy sector hosted by the US-Pakistan Center for Advanced Studies in Energy and NUST Institute of Policy Studies. Having spent eight months in Pakistan and visiting NUST on multiple occasions, the speaker noted that her interactions with the NUST community reinforced her belief in the university's vital role in Pakistan's energy sector.

She recounted that from 2015 to 2019, USAID and NUST partnered to establish a new energy degree program, supporting applied

research, and funding scholarships in energy studies. She further expressed immense pride in seeing how this initial investment and partnership had flourished, turning the efforts into a thriving hub for energy innovation that addresses Pakistan's critical energy needs. The speaker congratulated everyone for their hard work and dedication.

Additionally, she highlighted the establishment of similar institutions in Peshawar, Jamshoro, and Faisalabad, intending to address Pakistan's biggest development challenges, including energy, water, agriculture, and food security. These centers have also become vibrant hubs for innovation, thanks to enduring partnerships between academia and industry.

The speaker further underlined two proud legacies of the US government in Pakistan. The first is the legacy of quality higher education, empowering youth from diverse backgrounds to become future leaders in the energy sector. She noted the significant increase in the enrolment of women and their growing presence in the energy sector, recognizing the fresh perspectives, skills, and talents that women bring. She specifically acknowledged the women engineers, students, and faculty leading in STEM, and encouraged continued support for diverse youth and populations.

The second legacy emphasized was the enduring partnership with Pakistan, especially in the energy sector. The speaker noted that the

US has been a partner in Pakistan's energy journey since the 1950s, contributing to the national grid and supporting infrastructure projects like the Mangla and Tarbela dams. She mentioned promoting policy reforms to enhance the sector's efficiency and sustainability, with a growing focus on climate-smart energy solutions. She also highlighted the broader US government's involvement through the Department of Energy in funding research, policy development, and energy efficiency initiatives, underscoring the innovative, integrated, and sustainable clean energy solutions witnessed at the centre.

In her closing remarks, the speaker extended gratitude to the leadership, faculty, and students of NUST for their continued dedication to making the institution a vibrant hub of learning and innovation, as demonstrated in the seminar. She urged the students to boldly embrace the opportunities before them, recognizing their journey's successes and setbacks as integral to making their mark. The speaker affirmed that the students are the future of Pakistan, and the future is in their hands.

3. Transforming Pakistan's Energy Sector: Synopsis of Sector' Problems and Their Solutions

Mr. Muhammad Ali

Former Caretaker Federal Minister for Energy, Power and Petroleum

The energy sector in Pakistan is beset with a myriad of challenges that impede its efficiency, sustainability, and overall contribution to national development. Despite possessing considerable natural resources, the country has struggled to harness its potential due to a complex interplay of policy failures, infrastructural deficiencies, and regulatory bottlenecks. Mr. Ali dissected twenty primary issues plaguing Pakistan's energy landscape, ranging from declining indigenous production and inadequate pipeline networks to foreign investor distrust and rising circular debt. By dissecting these multifaceted problems, he provided a comprehensive

understanding along with the considerable solutions to secure a stable and sustainable energy future for Pakistan.

Declining Indigenous Production: Pakistan's energy sector has witnessed a significant decline in indigenous production. Pakistan's challenge to significantly expand its domestic production of natural resources, despite the discovery of the Sui gas field, exemplifies this issue. The policy framework has historically been unattractive for investments due to insufficient pricing mechanisms, and a lack of offshore exploration initiatives. Previously, several factors within the policy framework hindered companies from investing in Pakistan's energy sector, particularly for large-scale projects:

- The registration period for new energy projects was cumbersome and time-consuming, acting as a barrier to entry.
- Drilling success rates can be unpredictable, and the high upfront costs associated with drilling multiple fields presented a significant financial risk for investors.
- The past policy framework did not establish pricing structures that were attractive or predictable for energy companies, making long-term planning and investment less appealing.

Policy and Regulatory Failures: Ineffective policy frameworks and regulatory barriers have driven away foreign investment. Over the

past decade, ten major international energy companies have exited Pakistan, primarily due to delayed payments and an overall unfavourable business environment. For instance, last year a significant shift occurred in Pakistan's energy sector when Shell Petroleum, a leading multinational oil and gas company, concluded its divestment from its Pakistani subsidiary, ending a long-standing partnership that since 1947.

Offshore Exploration Failures: Pakistan's failure to attract investors for offshore resource exploration can be attributed to the absence of critical data and surveys. This lack of information creates uncertainty for potential investors, hindering development and forcing Pakistan to rely more heavily on expensive energy imports, which negatively impacts affordability. The speaker further stressed that offshore exploration has not yielded significant results, primarily due to inadequate surveys and data required to attract and guide investors.

Mr. Ali stressed that credible data collection, drawing on reliable sources, could provide a clearer picture of why companies are leaving and inform the development of more effective energy policies to attract future investment and promote domestic resource development.

Overdue Local Refinery Upgradation: The refining sector constitutes the backbone of Pakistan's industrial development. Unfortunately, Pakistan's refinery infrastructure is outdated and

unable to process modern crude oil, it refines crude oil into a variety of products critical for national functionality, including fuels for transportation, industrial processes, power generation, and other energy applications but are not satisfactory. The primary refining methods employed are hydro skimming, conversion/cracking, and deep conversion. Currently, Pakistan has five operational oil refineries: Pak-Arab Refinery Limited (PARCO), Attock Refinery Limited (ATRL), National Refinery Limited (NRL), Pakistan Refinery Limited (PRL), and Cnergyico Pk Limited (CNERGY). Mr. Ali further added that Pakistan has an oil refining capacity around 450,000 barrels per day (bpd), which is equivalent to 20 million tonnes per year.

Refinery	Year	Technology	Capacity (bpd)	Capacity (MT)
PARCO	2000 2010 (Euro II) 2011 (AABU) 2020 (upgrade)	Mild Conversion	120,000	5.5
ARL	1922(original) 1981(new) 1999(upgrade) 2016(upgrade)	Hydroskimming	53,400	2.4
NRL	1966(lube) 1977 (fuel) 2017 & 2018 (upgrade & revamp) 2021 (capacity enhanced)	Lube Refinery + Hydroskimming	70,000	3.2
PRL	1962 2015(upgrade)	Hydroskimming	50,000	2.3
CPL I	2004 (commissioned) 2008 (revamp/capacity enhanced)	Hydroskimming	36,000	1.6
CPL II	2015 (commissioned) 2017 (Upgrade Isomerization)	Hydroskimming	120,000	5.5
Total Capacity			450,000	20.5

Figure 1: Refining Industry and the Petroleum Products' Production and Consumption in Pakistan[1]

Mr. Ali further emphasized that a key challenge facing the sector lies in its technological composition. With the exception of PARCO's mild conversion refinery, all other facilities in Pakistan utilize hydro skimming technology, a less sophisticated method compared to conversion/cracking and deep conversion. This technological limitation restricts the refineries' ability to adapt their product output to meet changing market demands.

Furthermore, a significant discrepancy exists between Pakistan's refining capacity and its actual utilization. While the national refining capacity sits at approximately 20 million tons per annum (450,000 barrels per day) in FY23, the actual utilization rate is only around 50% (10 million tons per annum). This underutilization stems from a decline in furnace oil demand, primarily driven by a shift in the country's energy mix over the past few years. Power generation companies have reduced their offtake of furnace oil, leading to a decrease in overall refinery production and lower capacity utilization.

The speaker also mentioned about Pakistan's current refining capacity of 20 million tons cannot be fully utilized due to the declining demand for furnace oil within the power sector. Mr. Ali further stressed on the inflexibility of existing refineries in adjusting their product slate due to technological limitations. This inflexibility further hinders their ability to optimize production levels in response to market shifts.

Green-field Refinery Policy

Although playing a crucial role in the expansion of the economy, Pakistan has not witnessed the materialization of any major refinery projects for over a decade, with only two refineries being built in the past 40 years. The current capacity utilization of the refining industry is approximately 11 million tonnes, which is significantly lower than the total refining capacity of 20 million tonnes[1]. The primary reason for this is the declining demand for furnace oil in the country, which is a consequence of the power sector's shift in energy sources and the limited production capabilities of refineries, which are unable to exclusively produce petrol and high-speed diesel, resulting in simultaneous production of all products. Therefore, with the decrease in demand for furnace oil, refineries must reduce their overall production and have challenges in maintaining their throughput at appropriate levels.

Recognizing the refining sector's vital role in economic development, the government of Pakistan planned to attract new investment through Green-field Refinery Policy of 2023. The policy focuses on providing optimal tariff protection, similar to other local industries, to incentivize the construction of new refineries and related infrastructure projects. This includes the establishment of at least one new, large-scale (300-400kbpd) deep conversion refinery

[1] "PAKISTAN OIL REFINING POLICY FOR NEW/ GREENFIELD REFINERIES, 2023" (Directorate General (Oil), Petroleum Division, Ministry of Energy, Government of Pakistan, n.d.).

with a petrochemical complex. The speaker further emphasized that to address the challenge of low refining margins and encourage investment, the policy also outlines an incentive package alongside the tariff protection, aiming to improve the financial viability of future refining facilities and ultimately reduce Pakistan's dependence on imported petroleum products.

Limited Pipeline Network: The Pakistan's pipeline infrastructure is inadequate, affecting the efficient transportation of oil and gas. The lack of a comprehensive pipeline network hampers the movement of energy resources from production sites to consumption areas, particularly from the north to the south of Pakistan. The installation of more LNG terminals without the necessary pipeline infrastructure to transport gas from north to south has created significant logistical bottlenecks.

TAPI/IP Projects Issues: The Trans-Afghanistan Pipeline (TAPI) and Iran-Pakistan (IP) gas pipeline projects face numerous challenges, including logistical issues. The potential introduction of gas through the TAPI pipeline would face challenges related to the transportation of this gas within Pakistan, particularly from the southern region to the northern areas, due to inadequate internal infrastructure.

Windfalls from Cheaper Gas to Some Sectors: A significant challenge plaguing Pakistan's energy sector is the presence of unfair subsidies. In the past, fertilizer producers enjoyed access to natural

gas at a much lower price compared to other industries. This significant price disparity created windfall profits for these companies, disincentivizing investment in more competitive ventures. This phenomenon is not new in Pakistan's energy landscape.

The speaker further added that the governments in the past have employed various economic policy instruments to integrate underperforming sectors into the mainstream of economic development. These instruments have typically included adjustments to monetary policy, tariff protections, tax incentives, and subsidies. However, the effectiveness of these interventions has been a subject of debate. However, in the majority of cases, these rules mostly favour individuals who are already rich, resulting in instances where people attempt to clandestinely enjoy benefits that weren't meant for them. The speaker referred to it as a historical issue of "rent-seeking policies," where specific groups benefit from government interventions that distort market forces. These policies create an uneven playing field, hindering competition and hindering the development of a more efficient and equitable energy sector.

In this regard, Pakistan's energy sector has been tied to problematic agreements with private power producers (IPPs). Established in the 1994 Power Policy to attract investment, these contracts have backfired, contributing significantly to a ballooning national debt.

Mr Ali also added that major issue lies in the incentive structure offered to IPPs. The contracts guarantee returns linked to the US dollar. This means a weakening Pakistani rupee automatically increases IPP profits, leaving the government with a heavier financial load. Even with a reduction from 18% to 12% (Power Policy 2002), the guaranteed return on equity for IPPs remains well above global standards.

Furthermore, comparisons with similar projects elsewhere raise concerns about inflated costs. Mr. Ali further raised concerns that many IPPs secured funding through inflated invoices for equipment, essentially lacking "real" investment. This saddles Pakistan with ongoing pay-outs on what may be essentially "phantom equity."

Insufficient LPG Infrastructure: The infrastructure for liquefied petroleum gas (LPG) is underdeveloped. The country lacks adequate storage and transportation facilities, impeding the efficient distribution and utilization of LPG. The speaker added that SIFC is directed to enhance the LPG infrastructure in order to increase the distribution of supply throughout the entire country. Furthermore, it is actively pursuing investment opportunities in the area in addition to ensuring a consistent supply.

Unexplored Coal Gasification Potential: Pakistan has the world's 28th largest coal reserve of 185.175 billion tons.[2] Coal provides the present energy demand in Pakistan, accounting for 12.7% of commercial energy use over the 2017-2018 period. Given the extensive utilization of petroleum products, the importation of oil, LPG, and LNG will serve as a costly energy source in Pakistan. Coal, in contrast to other forms of energy, is very affordable and possesses reserves of 185.175 billion tonnes in Pakistan.[3] Nevertheless, Pakistan has persistently faced the challenge to promote the use of coal, especially in the past decade through initiatives such as the Alternative Energy Development Plan (AEDP), China Pakistan Economic Corridor (CPEC) and Vision 2035. The speaker stressed that Pakistan has vast coal reserves in the Thar region, yet coal gasification has not been adequately explored. Coal gasification offers a cleaner and potentially more efficient alternative to traditional coal combustion. By transforming coal into syngas, Pakistan could generate electricity, produce cleaner burning fuels, and contribute to a more flexible energy mix. Harnessing this resource could significantly reduce energy import dependence and enhance energy security.

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[2] Lin, Boqiang, and Muhammad Yousaf Raza. "Analysis of energy related CO2 emissions in Pakistan." *Journal of cleaner production* 219 (2019): 981-993

[3] Boqiang Lin and Muhammad Yousaf Raza, "Analysis of Energy Security Indicators and CO2 Emissions. A Case from a Developing Economy," *Energy* 200 (June 1, 2020): 117575, https://doi.org/10.1016/j.energy.2020.117575.

Underutilized Mineral Resources: Pakistan has not fully explored and utilized its mineral resources. Pakistan's vast mineral wealth, encompassing both non-renewable and renewable resources, presents a critical opportunity for the nation's future. These resources fuel various industries and commerce, but their sustainable utilization is paramount in light of global commitments like the Sustainable Development Goals. Recognizing this potential, economic giants like China see Pakistan as a strategic investment hub, particularly for shifting energy investments from coal to renewables. Further highlighting this significance of minerals, Saudi Arabia's mining vice minister estimates Pakistan's mineral deposits to hold a staggering $6 trillion value.[4]

Foreign Investor Distrust and Exit: There is a significant trust deficit among foreign investors, leading to their exit from Pakistan's energy sector. This not only results in financial loss but also deprives the country of advanced technologies and expertise.

High Transmission and Distribution (T&D) Losses: Pakistan's energy sector suffers from high transmission and distribution (T&D) losses by exacerbated by outdated infrastructure and inefficient management practices. Tackling this issue is crucial to reducing the circular debt burden. Since raising tariffs might face political resistance, focusing on T&D loss reduction offers a more

[4] "'From Dust to Development': Saudi Delegation Aims to Tap Pakistan's $6 Trillion Worth of Natural Deposits," *Arab News PK*, August 2, 2023, https://arab.news/zb9wt.

achievable path forward. To achieve this, energy officials should implement advanced technologies for pinpointing the root causes of these losses. Additionally, commissioning official studies would provide valuable data and analysis. Based on the findings, distribution companies with high loss rates should develop concrete action plans aiming for a 50% reduction within coming years.[5]

Rising Circular Debt: The circular debt in Pakistan's energy sector has ballooned due to unsustainable subsidies and political decisions prioritizing affordability over sustainability. The circular debt, which has exceeded Rs3,000 billion[6], presents a significant risk to the economic stability of the nation. This debt has been fuelled by unpaid subsidies, inefficiencies, and systemic corruption in the distribution and production chain. The speaker further added that it has also ballooned due to unsustainable subsidies and political decisions prioritizing affordability over sustainability. It highlights the urgent requirement for comprehensive reforms to reduce the financial burden and promote long-term sustainability. This debt has reached unsustainable levels, further straining the sector's financial health.

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[5] Michael Kugelman, "Easing an Energy Crisis That Won't End," in *Pakistan's Interminable Energy Crisis: IS THERE ANY WAY OUT?*, ed. Michael Kugelman (Wilson Center, 2015).

[6] "Inefficient Power Plants Exacerbating Circular Debt Crisis: Report," *DAWN.COM*, Pakistan, https://www.dawn.com/news/1833737.

Government Control and Inefficient SOEs: Government control over the energy sector, combined with inefficient state-owned enterprises (SOEs) and lack of regulatory accountability, has stifled progress. There are a total of 213 state-owned enterprises (SOEs) functioning at the federal level throughout different economic sectors. They are divided into 85 commercial state-owned enterprises (SOEs), 44 non-commercial SOEs (including trusts, universities, training institutions, and welfare funds), and 84 subsidiaries of commercial SOEs. In the case of Pakistan, state-owned enterprises (SOEs) have subpar performance and impose a substantial financial burden on the government.

According to recent data from the State Bank of Pakistan (SBP), the debt of public sector firms accounted for a significant 12.7% of GDP in September 2022, representing a year-on-year growth of 1.5%. It is crucial that State-Owned Enterprises (SOEs) that are still owned by the government have a clearly defined objective that is directly connected to the social goals they want to achieve.

Poor Planning and Contracting in IPPs: Inadequate planning and contracting practices in Independent Power Producers (IPPs) have led to unfavourable pricing mechanisms and rent-seeking behaviours. This has resulted in excessive returns guaranteed in US dollars, discouraging competitive business practices.

Energy Theft and Recoveries: Continual electricity theft is another significant issue contributing to the energy crisis. The lack of

accountability and enforcement exacerbates this issue. During the fiscal year 2022-2023, Pakistan incurred a loss of Rs380 billion as caused by power theft, and it is projected that this loss will increase to Rs520 billion in the following year.[7] The energy sector and the economy of the country are significantly affected by the combination of unpaid bills, power theft, and the increasing circular debt.

Regressive Subsidy Incidence: The subsidy system in Pakistan is regressive, benefiting certain sectors disproportionately while failing to address the needs of the most vulnerable populations. A more equitable subsidy distribution is essential for sustainable development.

Absence of Competitive Market: The lack of a competitive market in both power and gas sectors has led to inefficiencies and a lack of innovation. The government's role as a single buyer distorts market dynamics, necessitating a shift towards market-based mechanisms.

Lack of Energy Conservation and Transition Initiatives: Pakistan has made minimal progress in energy conservation and transition to renewable energy sources. Unlike other countries moving

[7] Fawad Yousafzai, "Country Lost Rs380b to Electricity Theft in Ongoing Fiscal Year," *The Nation*, February 18, 2023, sec. Business, https://www.nation.com.pk/18-Feb-2023/country-lost-dollar-380-billion-to-electricity-theft-in-ongoing-fiscal-year.

towards electrification, Pakistan remains heavily reliant on traditional energy forms.

Absence of Coordinated Energy Planning: There is a lack of coordinated energy planning in Pakistan, with various segments of the sector operating in silos. This disjointed approach hinders the development of a comprehensive and sustainable energy strategy.

Pakistan's Future Energy Mix will be Dominated by Imported Fuels

The speaker highlighted the challenging situation of Pakistan's diminishing gas reserves, causing concern for the future composition of energy sources. Pakistan's future energy mix will be dominated by imported fuels (LNG, POL, Crude) - Energy import bill of USD 17.5 billion in FY 2023 expected to increase up to USD 60 billion in next 20 years. Due to this the use of LNG is projected to double, leading to an increase in import expenses, and the utilization of coal is expected to increase by 20 percent. In addition to this, Pakistan's energy mix comprises natural gas, petroleum, electricity, coal, and liquefied petroleum gas (LPG).

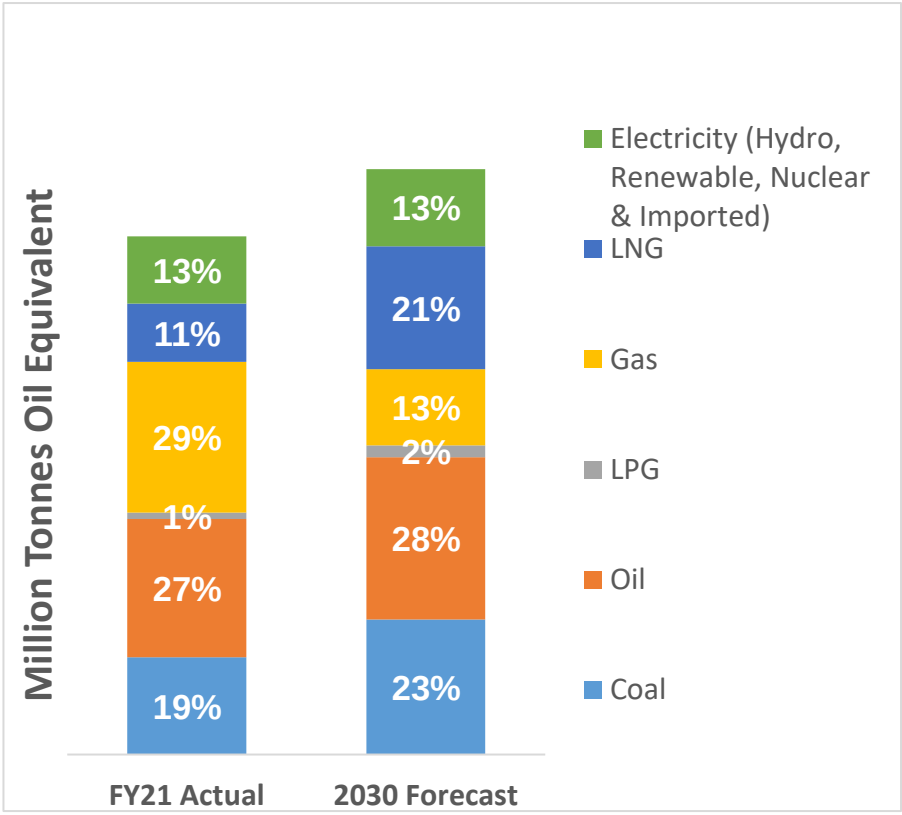

Figure 2[8]

Pakistan's future energy mix is projected to be heavily reliant on imported fuels such as Liquefied Natural Gas (LNG), petroleum products (POL), and crude oil. In Fiscal Year 2023, the country's energy import bill stood at USD 17.5 billion and is expected to surge to USD 60 billion over the next 20 years. Currently, Pakistan imports approximately 29% of its gas, 85% of its oil, 20% of its coal, and 50%

[8] The figure in this section is extracted from Mr. Mohammad Ali's presentation during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

of its Liquefied Petroleum Gas (LPG), although LPG constitutes a minor component of the overall energy landscape.

Mr. Ali further stressed that without significant increases in domestic production, the share of LNG in Pakistan's energy mix will rise from 11% in 2021 to 21% by 2030, while oil imports will remain relatively steady at around 27%. If indigenous production does not improve, the reliance on imported energy will intensify, with nearly all of Pakistan's energy needs being met through imports by 2030. This dependency underscores the critical need for Pakistan to enhance its exploration and extraction of domestic resources, particularly gas, to mitigate the escalating import bill and conserve foreign exchange reserves.

The Gas Production in the Country has Plummeted 5-7% Annually and Forecasted to Further Decline in Future

Over the past decade, Pakistan has experienced a significant decline in its domestic oil and gas production, which has exacerbated the country's energy challenges. Ten years ago, Pakistan was producing approximately 95,000 barrels of oil per day, but this figure has dropped to 70,000 barrels today, representing a reduction of 25,000 barrels per day. This decline equates to a loss of roughly $700 million annually from domestic resources. Similarly, gas production has also seen a decline; from around 4.1 billion cubic feet per day (BCFD) ten years ago, it has decreased to 3.3 BCFD. This reduction of 800 million cubic feet per day (MMCFD) in gas

production, largely due to the depletion of the Sui gas field, results in an annual economic loss of approximately $2.9 billion.

The implications of this decline are profound. Instead of capitalizing on its domestic resources, Pakistan has increasingly relied on imported energy, spending around $3.5 billion annually on LNG imports. This reliance on imports not only strains the country's foreign exchange reserves but also contributes to enriching other nations. In this context, Pakistan's need to enhance its domestic energy production capabilities becomes even more critical to reduce financial outflows, ensure energy security, and achieve economic stability.

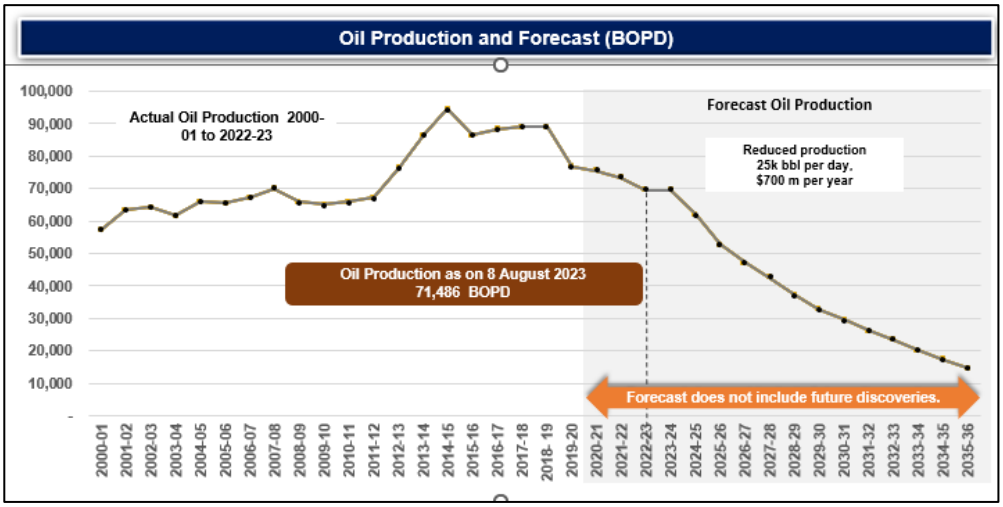

Figure 3: The crude oil production in the country has nosedived in last decade and forecasted to further decline[9]

[9] The figure in this section is extracted from Mr. Mohammad Ali's presentation during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

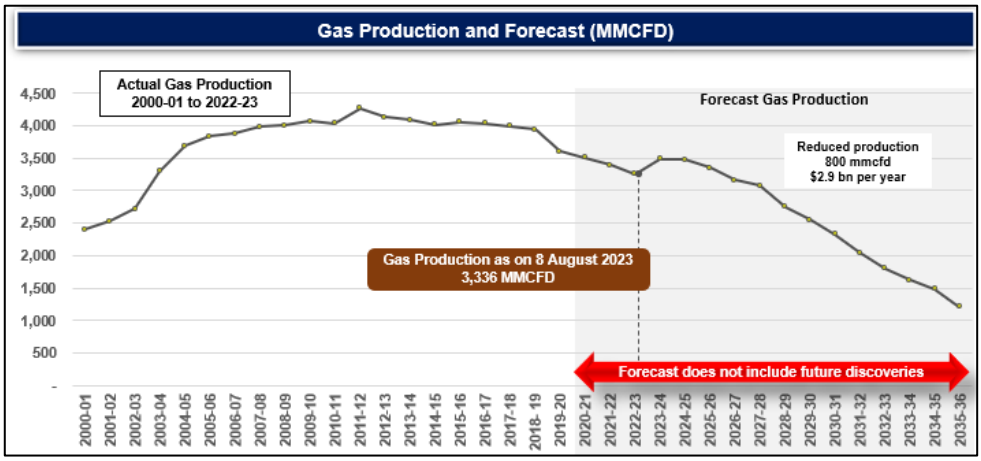

Figure 4: The gas production in the country has plummeted 5-7% annually and forecasted to further decline in future [10]

Pakistan has vast untapped natural reserves of gas and oil. To understand the immense potential of Pakistan's energy sector, it is essential to consider the country's untapped natural gas reserves, estimated at 66 trillion cubic feet (TCF). According to data from the Ministry of Energy, if Pakistan can recover just 10% of these natural gas reserves, it would result in a value of approximately $38 billion over several years. Additionally, Pakistan's tight gas reserves, which remain largely unexplored, hold significant promise. However, until recently, Pakistan lacked an attractive policy for international investors in the tight gas sector.

[10] Ibid.

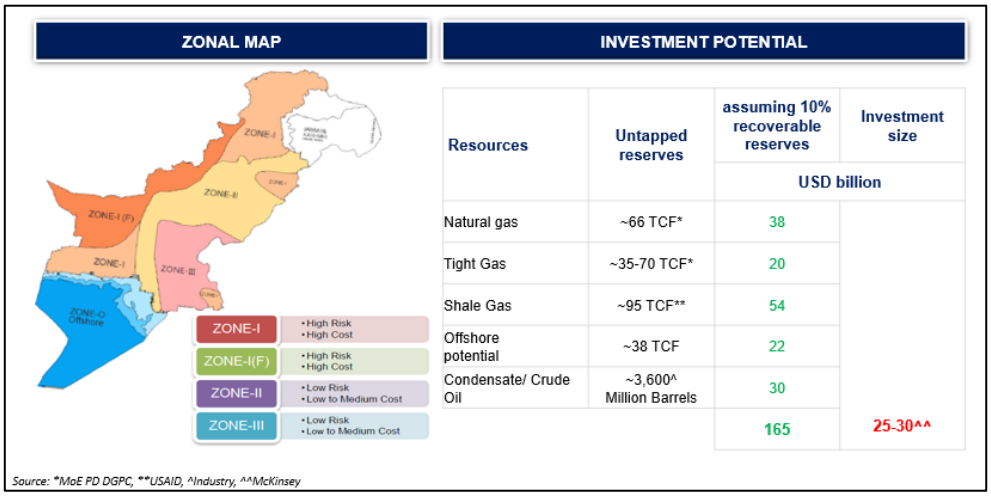

Figure 5[11]

Resolving Pakistan's Energy Crisis: A Multi-Pronged Approach

Pakistan's chronic energy crisis demands a comprehensive and multifaceted solution.

Devolving Power for Effective Governance:

The current energy sector suffers from a fragmented structure. To address this, a restructuring was recommended by the speaker.

- **Strengthened Regulatory Bodies:** Revamp regulatory institutions with a focus on monitoring, enforcement, and accountability. This includes empowering them with robust frameworks for data collection, analysis, and intervention.

[11] The figure in this section is extracted from Mr. Mohammad Ali's presentation during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

- **Syndicated Energy Ministry:** Establish a unified Ministry of Energy, consolidating the separate Petroleum and Power divisions. This ministry should be staffed with experts in various fields – energy economists, geologists, strategists, lawyers, and financial specialists – to ensure holistic decision-making.
- **Data-Driven Monitoring:** Develop real-time dashboards with Gantt charts and critical path analyses for all gas, oil, and mineral exploration projects. This will allow for transparent monitoring of progress from initial drilling to full operation.
- **Restructuring Support Agencies:** Revamp institutions like the Geological Survey of Pakistan (GSP), Hydrocarbon Development Institute of Pakistan (HDIP), National Energy Efficiency and Conservation Authority (NEECA), and the Minerals Development Wing to enhance their effectiveness in resource exploration, development, and efficiency promotion.

Fostering Competition for Efficiency:

The dominance of cartels and monopolies has stifled innovation and efficiency gains. Mr. Ali mentioned a few measures which are needed to introduce competition:

- **Privatization of Distribution Networks:** Privatize electricity transmission and distribution companies to introduce market forces and improve service delivery.
- **Unbundling SUI Companies:** Separate the transmission and distribution functions within Sui companies (natural gas supply companies) to create a more competitive landscape.
- **Open Market Access:** Allow private sector participation across all segments of the energy supply chain. This will encourage commercially driven solutions and market-based pricing.
- **Regulating Fertilizer Subsidies:** Implement a stricter regulatory framework for the fertilizer industry. While maintaining government commitment to this crucial sector, measures should be taken to prevent undue windfall profits.

Enhancing Resource Knowledge:

Improved resource documentation is essential for informed decision-making:

- **Telemetric Well Monitoring:** Implement telemetric systems on wellheads to gather real-time data on gas and crude oil reserves, enabling accurate assessment of available resources.
- **Comprehensive Geological Data:** Consolidate and update offshore and onshore geographical data, geological maps,

and seismic studies. This will provide a clear picture of Pakistan's energy potential.

- **Global Fuel Supply Channelization:** Develop a robust mechanism for sourcing imported fuels efficiently, optimizing costs and ensuring supply security.

4. Establishing a Strategic Planning Unit:

A dedicated strategy and analysis wing will guide long-term energy security:

- **Holistic Demand-Supply Assessment:** Develop a comprehensive plan to assess and forecast Pakistan's energy demand and supply requirements.
- **Sustainable Development Strategies:** Formulate long-term strategies and policy frameworks to ensure sustainable energy development while optimizing energy security.
- **Market Analysis and Price Forecasting:** Establish a system for monitoring international energy market trends, analysing domestic prices, and developing accurate price forecasts.
- **Affordability and Subsidy Management:** Design a targeted and sustainable subsidy mechanism that ensures social affordability of energy while minimizing fiscal burdens.

Expanding Domestic Resource Exploration:

To lessen dependence on imported fuels, Pakistan needs to prioritize indigenous resource exploration:

- **Investment Incentives:** Revise policies and develop action plans to attract investment in exploring domestic reserves of gas, minerals, and coal. This could involve tax breaks, streamline permitting processes, and guarantees of fair market access.
- **Thar Coal Gasification:** Investigate the feasibility of utilizing Thar coal reserves for gas production through coal gasification technology. This could provide a cost-effective alternative to imported natural gas.
- **Monetizing Precious Minerals:** Harmonize legal and regulatory frameworks alongside the National Mineral Policy to facilitate the extraction and monetization of precious metals. This strategy should prioritize local production and value addition for these resources.

Embracing the Energy Transition:

The global energy landscape is shifting towards cleaner sources. Pakistan needs to adapt:

- **Roadmap for Clean Energy:** Develop roadmaps for transitioning towards trending energy sources like

hydrogen, solar power, electric vehicles, green ammonia, and critical minerals for renewable energy technologies.

- **National Renewable Energy Policy:** Implement a comprehensive national renewable energy policy with a corresponding action plan and a monitoring framework for tracking carbon footprint reduction. Encourage state-owned entities (SOEs) to transform into holistic "Energy" companies or establish dedicated subsidiaries to lead the clean energy transition.

Upgrading Infrastructure for Efficiency:

Investing in energy infrastructure will optimize resource utilization and distribution:

- **LNG Infrastructure Expansion:** Develop robust Liquefied Natural Gas (LNG) infrastructure that aligns with projected demand to ensure future energy security.
- **LPG Conversion Strategy:** Formulate a roadmap and strategy for the conversion of the domestic sector to Liquefied Petroleum Gas (LPG) as a cleaner and more efficient cooking fuel.
- **SOE Infrastructure Development:** Empower SOEs to develop crucial infrastructure that facilitates widespread accessibility of energy across the country.

- **Pipeline Project Completion:** Develop a clear strategy for completing the Trans-Afghanistan Pipeline (TAPI) and Iran-Pakistan (IP) pipeline projects. This should involve securing G2G (government-to-government) investment and ensuring compliance with international regulations.

Mitigating Losses:

Energy losses throughout the transmission and distribution network significantly impact overall efficiency. Measures are needed to address this:

- **Town Border Stations and Accountability:** Implement Town Border Stations for metering energy at the entry point of each town. This decentralizes profit and loss (P&L) responsibility and incentivizes local efforts to reduce theft and improve distribution efficiency. Anti-theft mechanisms and recovery efforts should also be strengthened.
- **Circular Debt Resolution Strategy:** Develop a comprehensive strategy to address the issue of circular debt, both in terms of existing debt and future prevention. This should include plans for managing current debt levels and establishing mechanisms to ensure smooth financial flows within the energy sector.

Fostering Energy Conservation:

Promoting energy conservation is crucial for reducing overall demand and strain on the energy system:

- **Smart Appliances and NEECA's Role:** Invest in research and development (R&D) for smart and energy-efficient appliances. The National Energy Efficiency and Conservation Authority (NEECA) can play a vital role in promoting and incentivizing the adoption of such technologies.
- **Global Knowledge Exchange:** Establish international knowledge exchange programs to learn from successful energy conservation strategies and explore alternative energy sources implemented elsewhere.
- **Domestic Solarization:** Encourage and support the widespread adoption of solar power installations for domestic use, mitigating reliance on the national grid.
- **National Energy Benchmarks:** Establish national Key Performance Indicators (KPIs) for energy consumption and environmental impact, such as per capita energy consumption and carbon footprint. Regularly monitor and report on these metrics to track progress towards energy efficiency goals.

- **Alternative Fuel Models:** Explore the feasibility and sustainability of producing Natural Gas Liquids (NGLs), Synthetic Natural Gas (SNG), and various types of hydrogen (green, grey, and blue) as value-added products from domestic resources. This can enhance energy security and promote sustainable energy practices.

Ensuring Affordability for Consumers:

Making energy affordable for all citizens is a key social and economic objective:

- **Eliminating Cross-Subsidies:** Remove existing cross-subsidies within the energy sector, ensuring that all consumers pay a fair and transparent price for the energy they use.
- **Broadened Tax Base:** Broaden the tax base to generate additional revenue and reduce the burden placed on energy utilities.
- **Targeted Subsidies:** Design robust and sustainable targeted subsidy programs that provide support to vulnerable populations. These programs should include a clear exit strategy to ensure their long-term financial viability.

4. Planning Pakistan's Energy System for Sustainable Development

Dr. Fiaz Ahmad Chaudhry
P.Eng., Ph.D. Director, LUMS Energy Institute

To effectively address the challenges in Pakistan's power sector, a comprehensive strategy is crucial. This strategy should include enhancing capacity building, instituting merit-based leadership, and implementing efficient management models for state-owned enterprises, along with demand-side management. The adoption of energy-efficient building codes, advancement of industrialization, and tariff reduction through financial engineering are critical. Additionally, digitizing distribution companies, fostering a carbon-neutral energy landscape, and expediting electricity market reforms will improve transparency and efficiency. Establishing a National Energy Security Council, reforming procurement and planning

processes, creating a unified energy regulator, reducing political interference, and increasing public awareness of energy efficiency are essential for achieving a sustainable and reliable energy future.

Energy plays a vital role in driving national development, as it has become increasingly indispensable in every aspect of our daily lives. This reliance acts as a crucial measure for evaluating a country's technological and developmental advancement. Energy is crucial in residential spaces for the operation of lighting, heating, and various appliances. In transportation, it powers all modes of transportation, from personal vehicles to public systems, playing a crucial role in enabling mobility and facilitating commerce. The smooth operation of corporate buildings and the manufacturing sector heavily depends on a consistent and reliable energy supply, highlighting its crucial role in driving economic productivity. In addition, the widespread use of digital devices, internet services, and telecommunications emphasizes the importance of energy in sustaining connectivity and the flow of information.

Energy Usage in Pakistan

In Pakistan, energy usage is primarily concentrated in residential areas, with electricity being predominantly consumed in homes and, to a lesser extent, in commercial and office buildings. Industrial use accounts for only about 22% of total energy consumption, with limited application in agriculture. This

distribution poses a significant challenge, as the majority of energy is not directed toward productive sectors, impacting overall economic efficiency and development.

Power System Infrastructure

The power system is strategically designed with key components located near energy sources such as Thar coal mines, and Tarbela and Mangla water sources, aiming to minimize transportation costs. Additionally, placing generating units and reactive power compensation equipment near load centers is essential for maintaining stable frequency and voltage levels in compliance with electrical regulations.

Aligned with these operational strategies, the development objectives of the power system prioritize affordability for consumers, sustainability through dependable resource supply chains, and the provision of reliable, high-quality power. This integrated approach not only enhances operational efficiency but also addresses persistent economic and environmental challenges critical for building a resilient energy infrastructure.

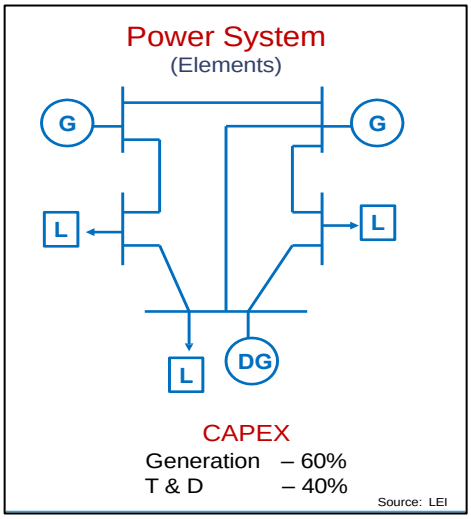

Figure 1[12]

Strategic Decisions in Energy Management

1. Capacity Planning

1.1 Determining Capacity Requirements

1.1.1 Demand Fluctuations: Capacity planning in the power sector is a meticulous process aimed at ensuring a consistent and dependable energy supply. Energy demand varies significantly between day and night and across seasons, with lower demand at

[12] The figure in this section is extracted from the presentation of Dr. Fiaz Ahmad Chaudhry during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

night and higher demand during the day, especially in summer. Proper capacity planning should account for these fluctuations.

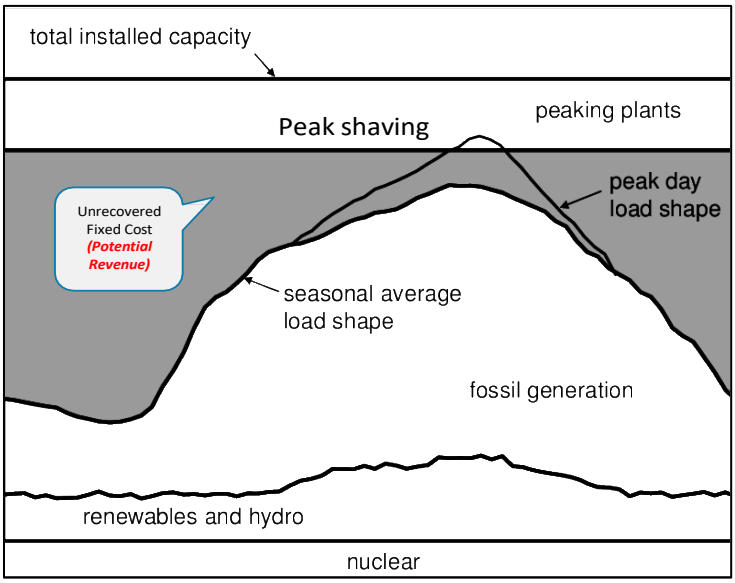

Figure 2[13]

1.1.2 ***Reserve Margin***: Estimating the required capacity involves forecasting peak load and adding a planning reserve margin, typically 10-20%, to account for uncertainties such as plant maintenance, outages, fuel constraints, and network constraints.

1.2 Demand Control

[13] The figure in this section is extracted from the presentation of Dr. Fiaz Ahmad Chaudhry during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

1.1.1 Importance of Demand Management: Modern nations control their demand to prevent overbuilding capacity and avoid financial inefficiencies. Pakistan has historically failed to manage its demand effectively, leading to economic losses.

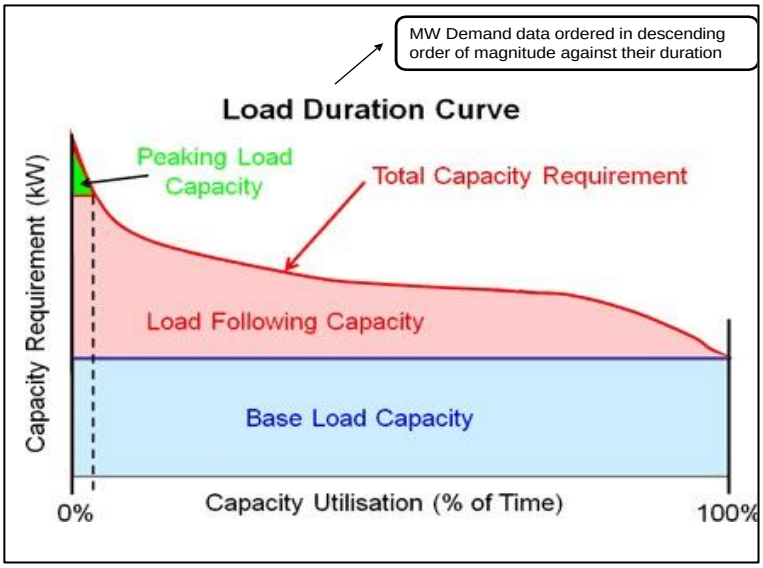

Figure 3[14]

1.1.2 Peak Forecasting: Accurate peak demand forecasting is crucial. The NTDC has historically provided these forecasts and highlighted the importance of involving private power

[14] The figure in this section is extracted from the presentation of Dr. Fiaz Ahmad Chaudhry during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

producers (IPPs) in national development emphasizing the necessity of private sector involvement for sustainable energy development.

1.2 Resource Adequacy

1.2.1 ***Rigorous Analysis****:* Achieving optimal generation capacity requires alignment of supply with dynamic demand patterns that fluctuate over short and seasonal cycles. This necessitates rigorous analysis, considering uncertainties such as plant maintenance schedules, unforeseen outages, fuel availability, and network constraints—all of which impact the reliability of power supply.

1.2.2 ***Probabilistic Measures****:* Using probabilistic measures to estimate potential capacity shortfalls ensures that the generation mix comprising coal, hydroelectric, and renewable sources—must effectively meet fluctuating load requirements while ensuring cost-efficiency, reliability, and security at all times.

2 Energy Resource Planning

2.1 Low Duration Curve Analysis

2.1.1 ***Peak Demand Duration****:* The planning of energy systems is important by analysing capacity utilization to balance demand and supply for individual, social, and business needs. Plotting demand in reverse order (low duration curve) helps determine the frequency and duration of peak

demand. This analysis informs decisions on base load and load-following capabilities.

2.1.2 ***Demand Control:*** Effective demand control measures are necessary to manage peak loads and avoid the need for excessive installed capacity.

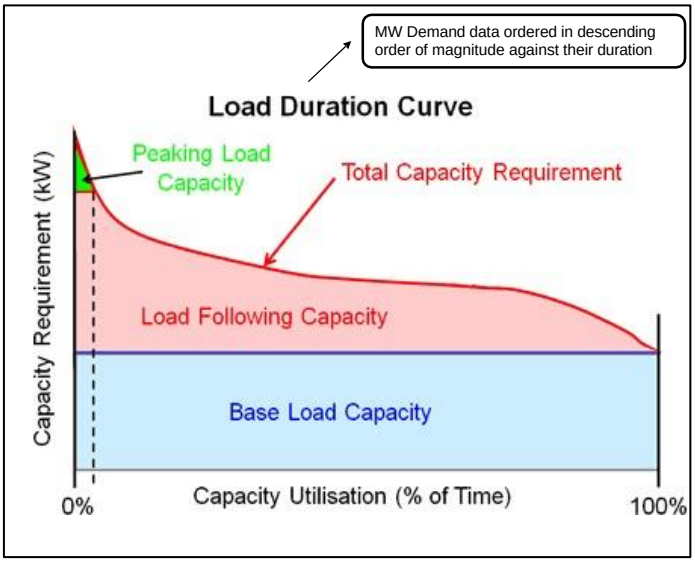

Figure 4 [15]

2.2 Capacity Utilization

2.2.1 ***Balancing Demand and Supply:*** Proper capacity utilization ensures a balance between demand and supply for individual, social, and business purposes.

[15] The figure in this section is extracted from the presentation of Dr. Fiaz Ahmad Chaudhry during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

2.2.2 ***Base-Load Plants:*** High-efficiency plants with abundant fuel availability (e.g., coal, nuclear) are suitable for base-load operations, requiring high capital expenditure (CAPEX) but offering low operational expenditure (OPEX), using abundant fuels like coal and nuclear power.

2.2.3 ***Load-Following Plants:*** Flexible plants with low start-up costs e.g., combined cycle gas turbines (CCGT) and hydroelectric power are suitable for load-following operations.

2.2.4 ***Peaking Plants:*** Fast-start plants with high OPEX but low CAPEX (e.g., OCGT, FO, diesel) are suitable for meeting peak demands efficiently, ensuring system stability. Proper planning and technology selection are essential for a well-balanced and reliable energy system.

Integrated System Planning and Capacity Allocation in National Transmission & Despatch Company (NTDC)

National Transmission & Despatch Company (NTDC) employs an integrated system planning framework as the country's sole planner. Initially, it evaluates if the existing system can meet specific requirements, making numerous cost and pricing assumptions. Optimization algorithms and stakeholder consultations validate the conclusions. NTDC is required to submit its integrated system plan annually by April 30, considering fuel

availability and focusing on generation and transmission aspects, rather than resource allocation.

Integrated System Plan

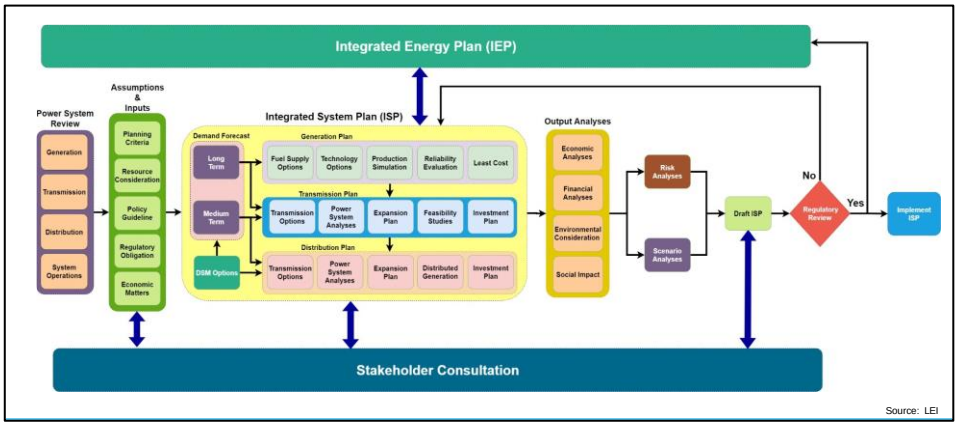

Figure 5[16]

Resource Planning by WAPDA and Current Energy Landscape

WAPDA initiated a 25-year resource plan, National Power Plan (NPP), in 1994, with subsequent publications. After three decades, the real-world situation reveals approximately 41,700 to 42,000 MW in the NTDC system, 2,900 MW in K-Electric, and 37,000 MW nationwide. The maximum availability in the NTDC system is 37,000 MW, with additional capacity from older or derated plants

[16] The figure in this section is extracted from the presentation of Dr. Fiaz Ahmad Chaudhry during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

during peak summer periods. Notably, 81% of demand originates from Punjab and KPK provinces, with 14% in KP and 67% in Punjab and IESCO. Deciding where to deploy resources is critical—whether in high-demand areas or remote regions prone to transmission constraints. With high recovery rates nearing 98%, the strategic placement of resources becomes a pivotal business decision.

Challenges in Sustainable Energy Management in Pakistan

The challenge in Pakistan's energy sector lies in avoiding mismatches where a 1,100 MW unit may exceed demand, risking operational collapse. Thus, maintaining integrated capacity planning remains essential for sustainable energy management. Pakistan's historical energy production peaked at 143 TWh during the 2021-2022 period. Monthly sales and generation figures from November to February averaged 8.5 TWh per month, estimating a total business activity of approximately 102 TWh annually, indicating a substantial operational scale. However, comparing the total production of 143 TWh with only 41 TWh effectively capitalized in 2016-17 highlighted a notable deficit.

Dis-Aggregating Demand Profile (NTDC System)

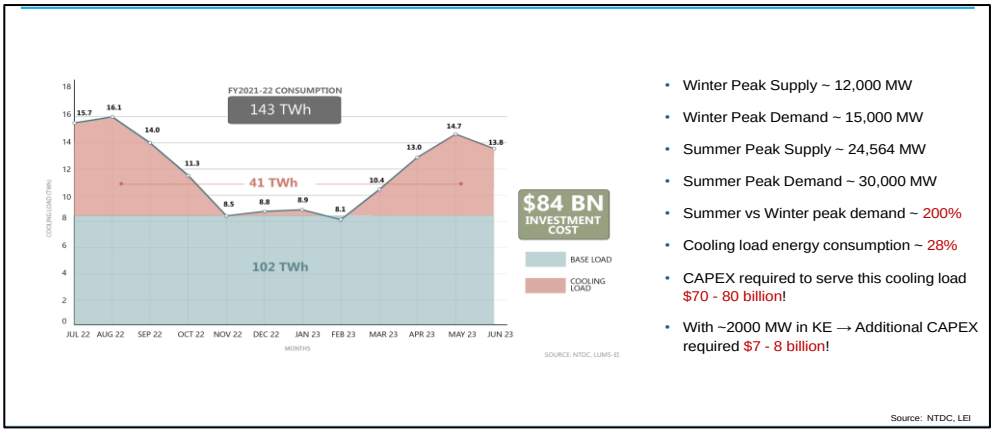

Figure 6[17]

Despite an installed capacity of 22,008 MW, operational challenges limited available capacity to around 21,000 MW. In subsequent years, peak demand reached 19,238 MW, with total business conducted that year amounting to 107 TWh. Although the peak capacity later increased to 41,000 MW, a decrease in business activities led to financial pressures from covering costs with available resources. This situation has contributed to a financial crisis over the past 14 years, primarily due to financial mismanagement rather than transmission or energy shortages.

Winter demands account for 11-12% of the total demand, increasing to 30-32% in summers, straining national resources and

[17] The figure in this section is extracted from the presentation of Dr. Fiaz Ahmad Chaudhry during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

accumulating debts exceeding 80 billion. This economic strain contrasts with the absence of significant transmission constraints or energy shortages, emphasizing the need for financial stability through reducing peak demands and optimizing capacity utilization.

To ensure sustainable energy management and mitigate financial burdens, educational efforts and capacity-building initiatives across sectors are essential. By addressing these challenges, Pakistan can work towards a more stable and efficient energy future.

Financial Crisis and Consumption Patterns

Pakistan spends $2.7 billion on heating during winter, adding to the financial strain. Building designs that necessitate air conditioning and heating contribute to increased energy consumption and peak demand. Capacity payments account for 72% of tariffs, reflecting the high operating costs due to infrastructure and contractual commitments.

Capacity and Demand Management

Pakistan has incurred over 80 billion PKR in debt to meet fluctuating energy demands, particularly the short-lived high demand during summer. This imbalance has significantly reduced the utilization factor, with a notable difference of 16,000 MW

between seasonal demands. The economic implications are substantial, as capacity payments, contractual obligations, and fuel costs add up significantly. For instance, the Re-gasified Liquefied Natural Gas (RLNG) combined capacity payment is 124 PKR, and the fuel cost is 921 PKR, leading to commitments exceeding one billion dollars. The financial crisis in the energy sector primarily stems from a misalignment between energy production and consumption, rather than from transmission or energy shortages.

Way Forward to Overcome Power Sector Challenges

1. **Capacity Building Programs**: Implement Professional Development Programs (PDP), Advanced Development Programs (ADP), and Continuous Professional Development (CPD) initiatives at all levels.
2. **Leadership Appointments**: Utilize head-hunters for hiring Managing Directors (MDs) and Deputy Managing Directors (DMDs) to ensure competent leadership.
3. **Management Model for SOEs**: Transition state-owned enterprises (SOEs) from a Service Model to a Management Model to enhance efficiency and accountability.
4. **Focus on Demand Side Management**:
    - Implement the Energy Efficient Building Code 2023 to reduce peak loads, particularly cooling loads.
    - Facilitate industrial growth through improved Ease of Doing Business to boost energy sales.

5. **Tariff Reduction Measures**: Use financial engineering techniques and adopt Cost of Service methodologies tailored for each consumer category to reduce tariffs.
6. **Digitization of DISCOs**: Enhance transparency and performance through the digitization of Distribution Companies (DISCOs), focusing on Key Performance Indicators (KPIs).
7. **Transition to Carbon Neutrality**: Strategically evolve the utility landscape to align with the carbon-neutral era, integrating renewable energy sources.
8. **Integrated Resource Planning (IRP)**: Implement an Integrated Resource and System Planning framework and empower an Independent System and Market Operator (ISMO) for effective implementation.
9. **Electricity Market Development**: Expedite the implementation of the Competitive Trading Bilateral Contracts Market (CTBCM) to enhance market efficiency.
10. **Establishment of National Energy Governance**: Formulate a National Energy Security Council (NESC) or National Energy Commission (NEC) with clear mandates and effective Board of Directors mechanisms.
11. **Structural Reform in Ministry of Energy**: Address structural flaws to ensure procurement processes follow strategic planning in the Power Division.

12. **Unified Energy Regulator**: Merge the National Electric Power Regulatory Authority (NEPRA) and Oil & Gas Regulatory Authority (OGRA) into a unified regulator to streamline governance.
13. **Minimize Political Interference**: Mitigate political interference in the Ministry of Energy and SOEs to ensure operational autonomy and efficiency.

5. Comprehensive Hydropower Development for Sustainable Energy Supply in Pakistan

Mr. N. A. Zuberi
Senior Advisor, China Three Gorges South Asia Investment Limited (C-SAIL)

Mr. N.A. Zuberi presented a comprehensive and thought-provoking investigation on the role of hydropower potential in shaping a sustainable energy future for Pakistan. He highlighted the immense resource availability, along with the government's power policies, regulatory framework, incentives, and strategic initiatives designed to enhance hydropower development in Pakistan. A significant portion of the presentation was dedicated to the Karot Hydropower Project, as a benchmark for best practices in this sector. The speaker detailed the project's implementation, impressive capacity, operational achievements, and positive impact on the surrounding community. Major challenges

faced by this sector, including environmental concerns, financial constraints, logistical hurdles, and policy implementation issues were highlighted. Practical recommendations such as the need for improved policy support, increased investment, efficient approval processes, stronger stakeholder collaboration, and attracting foreign investment were emphasized to overcome these hurdles to unlock Pakistan's hydropower potential to unlock the hydropower potential of Pakistan for sustainable development.

Dynamics of Hydropower

In the dynamics of hydropower section, the speaker discussed the approaches and constraints for sustainable development in hydropower projects in Pakistan. A compelling case was presented for hydropower development, emphasizing their technological, economic, and environmental benefits, as well as their critical role in water management for agriculture. The speaker underscored the remarkable longevity of these projects as compared to thermal projects and quoted the example of the Renala hydropower plant which was completed in 1925, and has been running profitably for almost a century, demonstrating the durability and long-term viability of such infrastructure. The speaker noted that hydropower is ideally suited for peak time demand requirements due to its instant start and stop function to handle load variations efficiently because it is crucial for maintaining grid stability and reliable power supply during periods of high demand. In terms of cost-

effectiveness, the speaker noted that these projects are cheaper in the long term, providing economic benefits, and reducing dependency on imported fuels, leading to significant savings in foreign exchange and improving the overall energy security of the country. He emphasized the broader socio-economic impact of hydropower projects, primarily in the less privileged areas as these projects contribute to job creation, infrastructure development, and stable energy supply in fostering growth and prosperity improving the quality of life of local communities.

Constraints Associated with Hydropower Projects: The speaker identified four key challenges for hydropower projects in Pakistan.

i. High initial investment and risks: The primary challenge is the huge capital cost associated with these projects due to high upfront capital costs including hydrological risks (unpredictable water flow) and geological (underground rocks) risks.
ii. Lengthy construction timeframes: The construction of these projects could take six to eight years demanding considerable patience and long-term effective planning.
iii. Social and political challenges: Hydropower projects often require the relocation of communities leading to complex social and political issues of resettlement and rehabilitation. Land acquisition was identified as one of the major hurdles to the successful development of such projects.

iv. Logistical challenges: Hydropower projects are typically located in less-developed areas lacking in necessary infrastructure such as roads, electricity, and construction materials. This increases the cost and complexity of these projects.

Desirability of sustainable development of hydropower projects: Due to several key factors, the speaker emphasized the need for hydropower projects in Pakistan. To start with, these projects highlight the technological maturity and operational efficiency in both base-load and peaking power. In terms of operational cost, the speaker noted that despite the initial capital investment, hydropower projects have relatively low costs and long lifespan of these facilities can significantly offset the initial cost. Additionally, hydropower projects can achieve energy conversion efficiencies up to 90% making them the most effective means of generating electricity from renewable energy resources. Moreover, these projects are crucial for water storage, which is essential for agricultural and irrigation leading to enhanced agricultural yield and contributing to food security in Pakistan. Furthermore, hydro power projects also play an important role in flood control and navigation.

Hydro Power Potential of Pakistan

The speaker provided a comprehensive summary of the status of hydropower projects in Pakistan. He shared that approximately 10,000 megawatts of projects are currently operational, and around 11,000 megawatts are under construction. The remaining projects are at various stages of feasibility studies or design.

Historical Context of Hydropower Development in Pakistan

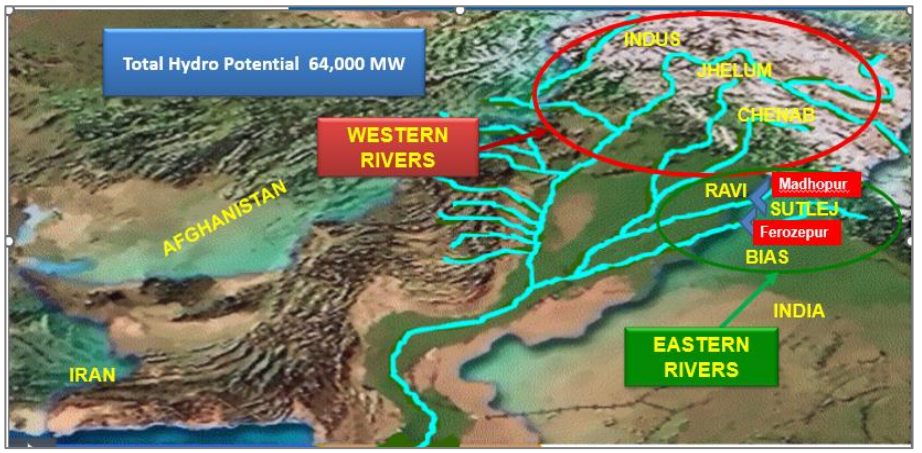

Figure 1: Indus River System[18]

The speaker provided the historical context of Pakistan's hydropower landscape since its inception. He underscored that Pakistan inherited six rivers in 1947, divided between eastern and western rivers. The Redcliffe Award demarcated the boundaries

[18] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

and placed two major headworks, Madhopur and Firozpur, on the Ravi and Sutlej rivers in India. India stopped the flow of water from these headworks in 1948, creating a severe agricultural and livestock crisis in southern Pakistan. Pakistan sought assistance from the World Bank to resolve the crisis which resulted in the Indus Water Treaty. The treaty allocated the western rivers—Indus, Jhelum, and Chenab to Pakistan, while the eastern rivers—Ravi, Beas, and Sutlej to India. The World Bank-backed accord contained provisions for the construction of eight barrages, six connecting canals, and three significant storage hydropower projects in Pakistan. In order to alleviate Pakistan's water problem and advance sustainable development, these initiatives sought to increase the nation's capacity for storing water, guarantee a steady supply of water for irrigation, and boost energy output.

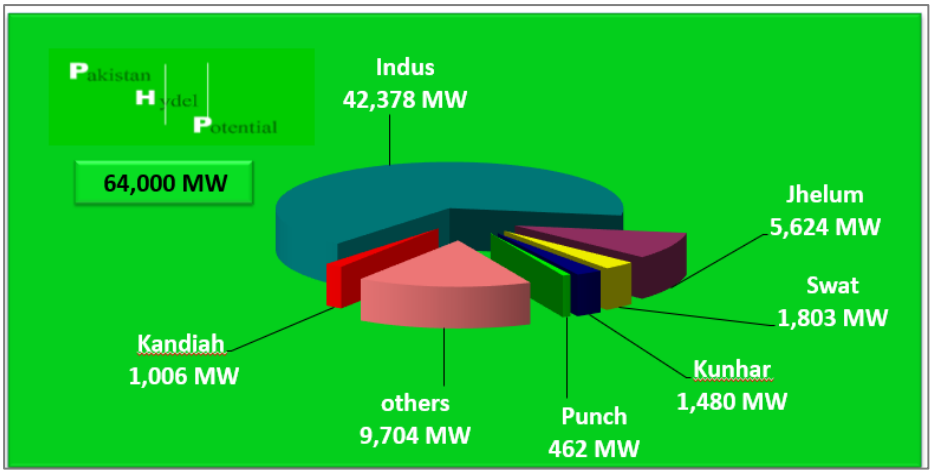

Figure 2: Hydro Power Potential of Pakistan[19]

Indus Cascade

The speaker noted that Pakistan has a significant hydropower potential, projected at 64,000 megawatts. Most of this potential, around 42,000 megawatts, is obtained from the Indus River and other notable contributions gained from the Jhelum River, Swat River, and additional smaller rivers. The Indus is the largest river in Pakistan and offers massive hydropower opportunities which is known as the Indus cascade.

[19] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

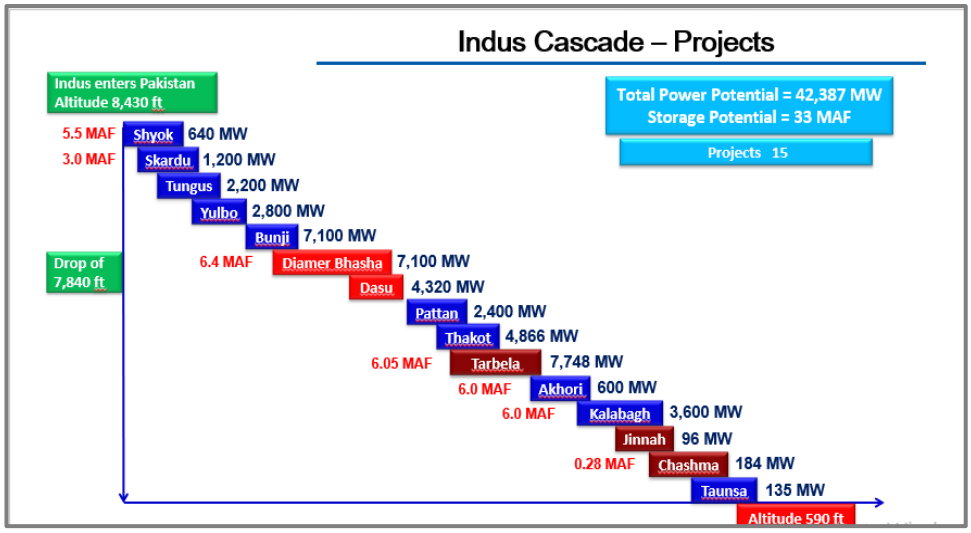

Figure 3: Indus River Cascade[20]

The river drops to around 5,595 feet when it enters Pakistan at Tonsa, 8,430 feet above sea level. There are around 15 project locations within this range, with a total potential of 43,387 megawatts. Tarbela, Jinnah, and Chashma are the three main hydropower projects on the Indus River that are currently in operation. Two further projects are currently in development. Every possible location for these projects has been found, and a number of them are currently undergoing pre- and feasibility studies in order to determine their viability and schedule further development.

[20] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

The speaker provided each region's hydropower potential capacity.

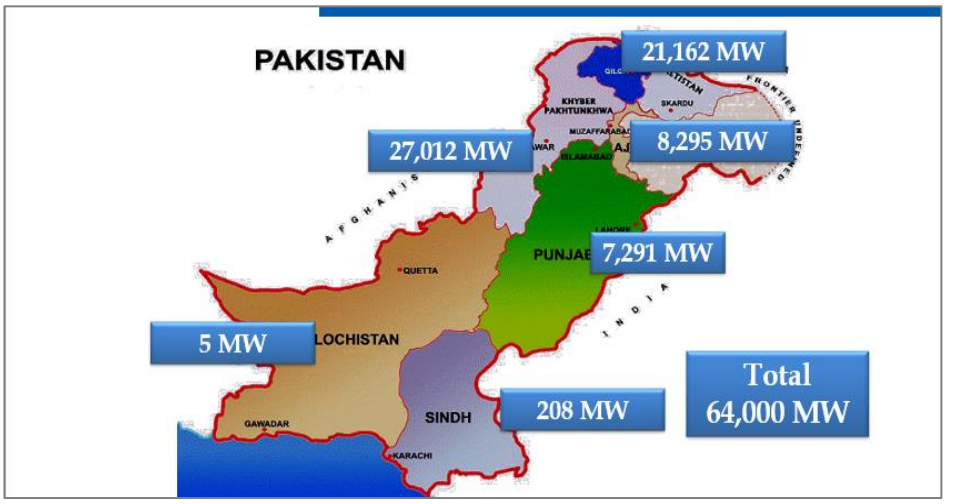

Figure 4: Pakistan's Hydropower Potential Locations[21]

The maximum potential of 27,000 megawatts is in Khyber Pakhtunkhwa (KPK), followed by 21,000 megawatts in Gilgit-Baltistan, and 8,000 megawatts in Azad Jammu and Kashmir (AJK). Punjab has a potential of 7,000 megawatts, while the hydropower potential in other regions is comparatively minimal.

[21] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

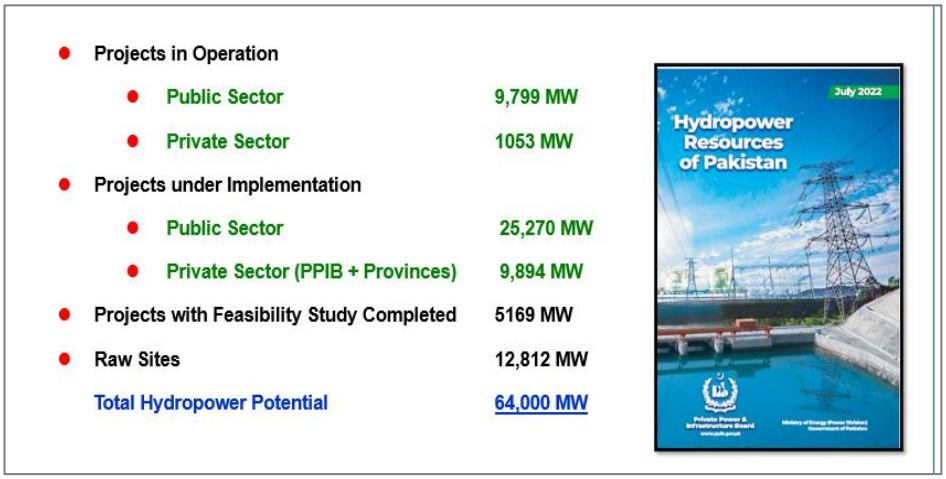

Figure 5: Breakdown of hydropower projects in Pakistan[22]

In the public sector, there are 9,000 megawatts of hydropower projects currently under construction. Additionally, in the private sector, around 1,053 megawatts of projects are operational.

Overview of Pakistan's Power Sector

The speaker noted that long transmission lines are required for projects in Pakistan as potential hydropower resources are located in remote areas of the country.

[22] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

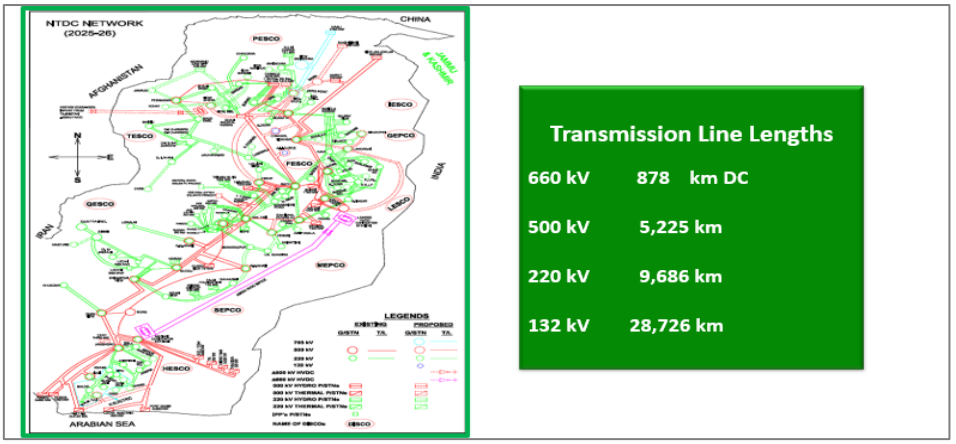

Figure 6: Pakistan power sector-Transmission system[23]

Pakistan Power Sector – Key Institutions

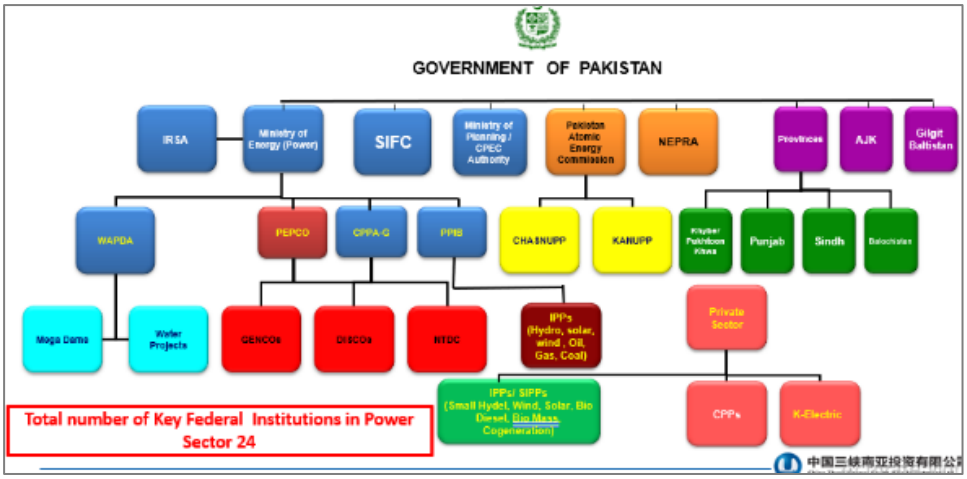

Figure 7: Pakistan Power Sector – Key Institutions[24]

[23] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.
[24] Ibid.

ENTITIES	YEAR OF CREATION	NO. OF YEARS SINCE CREATION	INSTALLED CAPACITY (MW)
K-Electric (formerly KESC)	1913	111	1875
PAEC	1956	68	3630
WAPDA	1958	66	9383
PEPCO/GENCOs	1958	66	5458
PPIB (Thermal, solar and Wind)	1994	30	23,905
PPIB (Hydro)	1994	30	1053

Figure 8: Federal power entities[25]

The speaker emphasized the intricacy of the power industry by pointing out that 24 distinct federal entities oversee business and matters related to power. Ten more institutions are active at the provincial level, bringing the total number of institutions working in the electricity sector to 34.

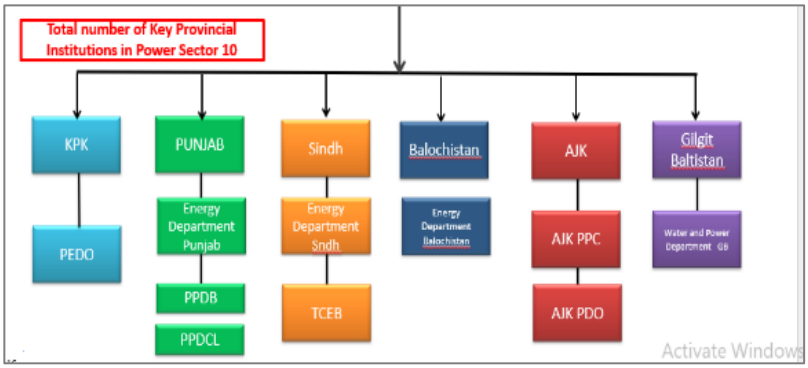

Figure 9: Provincial power sector players[26]

[25] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

[26] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

ENTITIES	YEAR OF CREATION	NO. OF YEARS SINCE CREATION	INSTALLED CAPACITY (MW)
PDO AJK	1989	28	68.22
PEDO	1986	31	163
PPDB Punjab	2006	11	11
Water and Power Department GB	2005	20	169

Figure 10: Provincial sector entities[27]

The speaker expressed dissatisfaction, noting that the organizations' lack of integration and isolation results in inefficiency and a lack of responsibility.

[27] Ibid.

Overview of Pakistan's Power Sector Capacity

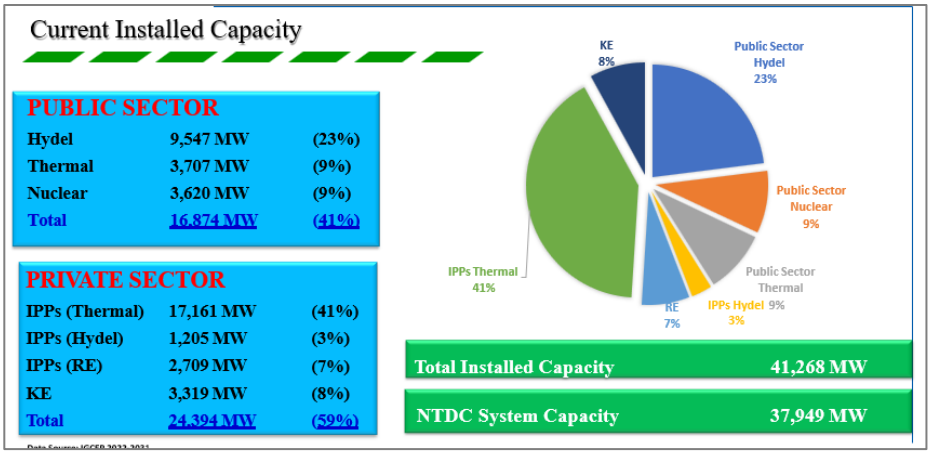

Figure 11: Pakistan's Power Sector Capacity[28]

The speaker provided a historical context, pointing out that K-electric formerly known as Karachi Electric Supply Company (KESE), in 111 years since its creation in 1913, the department has only produced 1875 megawatts. Comparably, in just 60 years from its founding in 1958, the Water and Power Development Authority (WAPDA) has produced 9383 megawatts of electricity. Private Power and Infrastructure Board (PID) was established in 1994, producing 1053 megawatts, with the goal of promoting hydropower in the private sector. At the provincial level, the Punjab Power Development Board (PDB), founded in 2006, produces only 11 megawatts, compared to the organization in KPK, established in 1988, with an installed capacity of 163 megawatts. 169 megawatts

[28] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

are produced by Gilgit Baltistan's Water and Power Department, which was founded in 2005.

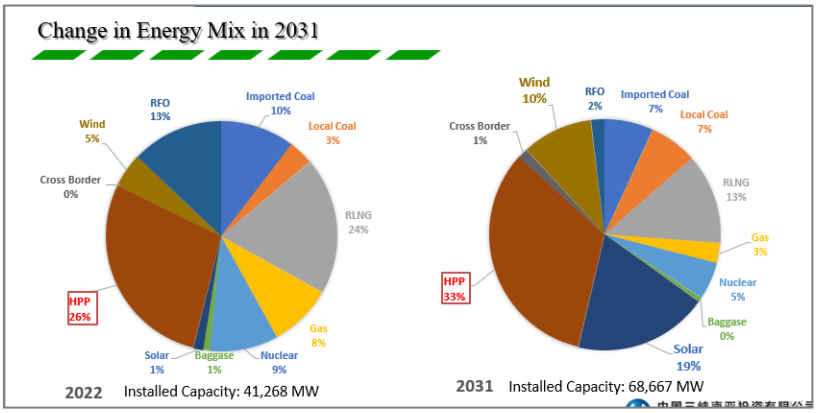

Figure 12: Pakistan's Energy Mix[29]

The speaker focused on Pakistan's present energy mix, which has about 41,000 megawatts of installed capacity overall. Of this, the private sector produces 59% of the energy, with hydropower making up 26% of the total capacity. The Pakistani government's efforts are greatly enhanced and supplemented by the private sector. IGG estimates that by 2031, hydropower will have increased from its present 26% share of the entire energy mix to 33%.

The speaker identified the obstacles demonstrated by the past results of public sector initiatives. For example, the 1997 completion

[29] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

of the Chashma 184 MW project involved a 60.9% cost overrun and a four-year schedule overrun. When the 450 MW Ghazi Barotha project was finally finished in 1999, it had 40 years of delays and a 42 percent cost overrun. The 969 MW Neelum-Jhelum project had startling 400% cost overrun and a three-year delay in completion. These illustrations draw attention to the inefficiencies and hold-ups that come with public sector initiatives.

He also noted that the government faced competing goals in the 1980s, including public health, education, agriculture, defence, and agriculture, and it had few resources. The government's budget was being significantly depleted by the power industry. The government chose to involve the private sector in power generating in 1985 as a response to this. The goal of this change was to free up government funding for other important sectors including agriculture, health, education, and infrastructure development.

Criteria for Development of Hydropower Projects in Public Sector

The speaker observed that Public Sector Projects are the Projects with seasonal storage involving extensive resettlement and rehabilitation. Private Power Projects are the simple run-of-river projects, which does not include components like irrigation, flood management, and navigation.

Efforts in Development of Hydro Power Projects in Private Sector

The speaker highlighted the efforts of private sector's efforts in developing hydro power projects in Pakistan including the publication of a comprehensive brochure on Pakistan's hydel power potential. In order to streamline development projects ranging from 50-1000 MW have been prioritized. Standardized terms of reference for bankable feasibility studies, and security documents such as Implementation Agreement (IA), Power Purchase Agreement (PPA), and Water Union Association (WUA) have been developed with active involvement of all stakeholders. Three-stage tariff determinations hydro framework has been published and cascade studies for River Swat and River Jhelum have been conducted for transparency, project planning, and implementation respectively.

Private Power Policies

The speaker argued that the Government of Pakistan (GoP) has produced around 18 power policies, among these only six were implemented, showing their ineffectiveness in attracting foreign investment. The speaker emphasized that from 1985 to 1994, the Government of Pakistan introduced six power policies. Unfortunately, these policies did not succeed in drawing investor interest. The speaker emphasized that the World Bank and the International Finance Corporation (IFC) started working together to identify the barriers preventing foreign investments in 1994.

Power Policy 2002 – Hydropower Specific Incentives

Several targeted incentives were provided in the Power Policy 2002 to promote the development of hydropower. Several reopeners in EPC (Engineering, Procurement, and Construction) contracts were permitted by NEPRA (National Electric Power Regulatory Authority). These reopeners included clauses allowing for cost escalation in civil and electrical & mechanical works, cost variations resulting from resettlement, and geological risks in tunnel areas. The strategy also guaranteed investors a 17% return on equity. After the Letter of Support (LOS) was issued, developers had up to 36 months to reach financial close.

Incentives for Investors Interested in the Development of Power Projects

A variety of incentives are offered by the policy to entice investors to create power facilities Such as exemption of Sales tax, turnover tax, withholding tax, and corporate income tax. Additionally, plants and equipment that are not produced locally are subject to a 5% concessionary import charge. In addition, the Policy provided protection against political force majeure, changes in the law and change in duties and taxes. The Government of Pakistan (GOP) also guarantees the payment obligations of power purchasers and provinces.

Tariff Structure in Three Stages for Hydropower Projects

The speaker highlighted the three phases of the hydropower project pricing structure. An indicative tariff based on the feasibility cost is used in Stage I. The EPC (Engineering, Procurement, and Construction) stage tariff is established in Stage II. It is based on EPC costs and incorporates some reopeners, such as geological conditions restricted to the tunnel region, cost escalation for civil works, and resettlement expenses. After reopeners are taken into account, Stage III establishes the final tariff at the Commercial Operation Date (COD).

IPP Model for Hydropower Projects in Pakistan

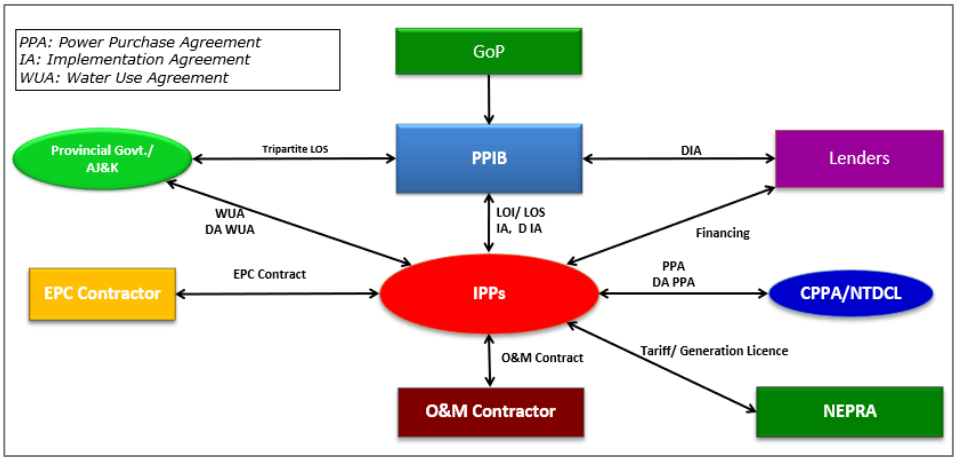

Figure 13: IPP model for hydropower projects in Pakistan[30]

[30] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

The speaker highlighted the model used by private sector to develop Hydro Power Projects in Pakistan which consists of a lot of Agreements which a IPP has to sign to develop and finance the Projects with various stakeholders He informed that in Pakistan Private Power and Infrastructure Board (PPIB) processes the private sector hydro power projects. The process involved by PPIB was also explained.

Power Policy 2002 - Process Raw Site Hydropower Projects

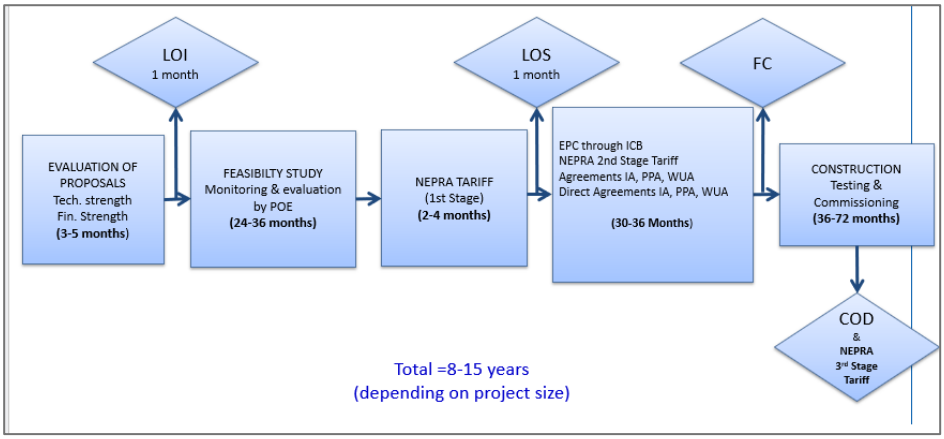

Figure 14: Power policy 2002-process raw site hydropower projects[31]

Environmental Considerations

Furthermore, the speaker emphasized that all hydropower projects are required to adhere to environmental guidelines according to

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Pakistani standards and lender requirements. This includes carrying out extensive environmental impact assessments to mitigate adverse effects. The speaker underscored the journey of projects like Mangla, which began in 1952 and completed in 1967, exemplifying the long-term commitment and intricate planning required for successful hydropower development in Pakistan.

Success Story of 720 MW Private Sector Hydro Power Project

Karot HPP – Pearl on Jhelum River

Figure 15: Karot HPP Site[32]

The speaker highlighted the remarkable success story of the Karot Hydropower Project (HPP) in the field of sustainable energy and infrastructure development, completed in record time and

[32] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

significantly enhancing Pakistan's energy landscape. Part of China's Belt and Road Initiative (BRI) and the China-Pakistan Economic Corridor (CPEC), this 720 MW project is an excellent example of global cooperation, well-thought-out planning, and cutting-edge engineering. The project produces clean, renewable energy with environmental conversation and empowering local communities through various initiatives. The project is developed by China Three Gorges Corporation (CTG), a state-owned power company, focusing on construction and operation of large-scale hydroelectric projects.

The CTG was founded in 1994 they are the owner, developer and operator of world largest hydro power project with a capacity of 22, 500 MW, at present they have installed capacity of more than 140,000 MW and have total assets surpassing tens of billions of dollars and an annual profit of $5 billion.

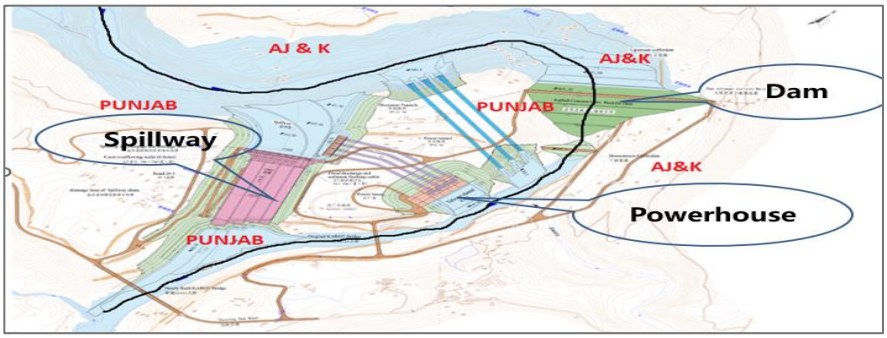


Figure 16: Project Layout[33]

[33] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

Unique and Distinctive Features of Karot HPP

The speaker highlighted several distinctive features of the Karot HPP constructed by the China Three Gorges Corporation (CTG), one of the leading experienced companies with the technical and financial strength to ensure the project's success. It's a unique public-private partnership endeavour established under the Power Policy 2002.

Figure 17: Strengths of Karot HPP[34]

Another distinctive feature is its strategic location under the CPEC, the project is located in Punjab and in AJK and very close to the national grid, minimizes transmission cost, requiring only a 3 Km line. Additionally, the project benefits from the strong security provided by Pakistan's armed forces. Being a renewable energy project, it has zero negligible ecological and environmental impact

[34] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

and it is the only project where a biodiversity management plan has been prepared. The holistic approach includes the positive social impact initiatives taken under the Corporate Social Responsibility (CSR) program. In order to uplift the surrounding communities, building hospitals, schools, bridges, and roads along with special scholarships in electrical engineering are being offered for students in the project areas.

Karot HPP Benefits and GOP Support

The project is a private sector initiative, and after 30 years of operation, it will be transferred to the Government of Punjab as it is in its jurisdiction. The project has created 5,000 employment opportunities for locals during its construction time and there are 150 locals are presently employed in the project's ongoing operations.

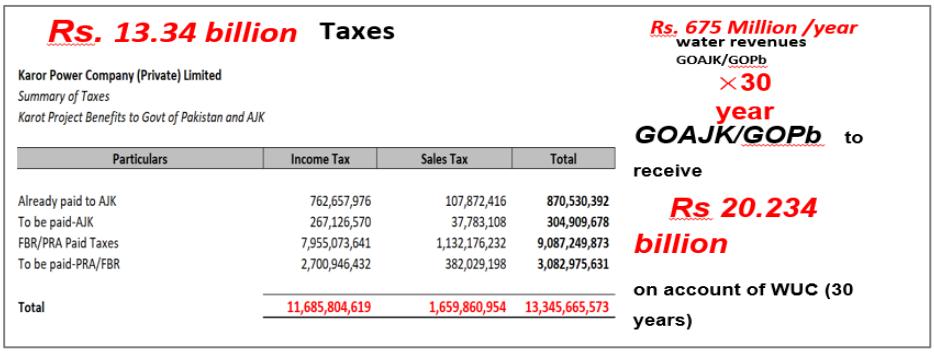
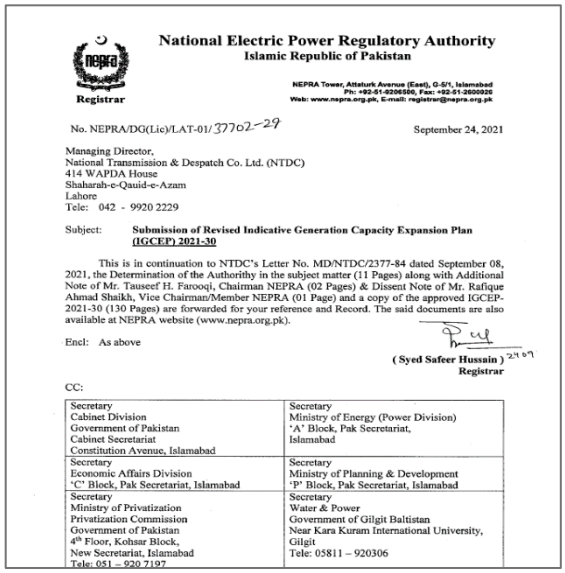


Figure 18: Karot HPP-GoAJK and GoPunjab[35]

[35] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

It is anticipated that the project will cut 3.5 million tons of carbon dioxide emissions annually. Moreover, it generates 3.206 billion kWh of clean energy yearly. The project's cost-effectiveness and reduction of carbon dioxide emissions.

The Karot HPP after successfully completing all Commissioning Tests as per provisions of the PPA achieved COD on Jun 29, 2022



National Electric Power Regulatory Authority
Islamic Republic of Pakistan

Registrar

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No. NEPRA/DG(Lic)/LAT-01/ 37702-29 September 24, 2021

Managing Director,
National Transmission & Despatch Co. Ltd. (NTDC)
414 WAPDA House
Shahrah-e-Qauid-e-Azam
Lahore
Tele: 042 - 9920 2229

Subject: **Submission of Revised Indicative Generation Capacity Expansion Plan (IGCEP) 2021-30**

This is in continuation to NTDC's Letter No. MD/NTDC/2377-84 dated September 08, 2021, the Determination of the Authority in the subject matter (11 Pages) along with Additional Note of Mr. Tauseef H. Farooqi, Chairman NEPRA (02 Pages) & Dissent Note of Mr. Rafique Ahmad Shaikh, Vice Chairman/Member NEPRA (01 Page) and a copy of the approved IGCEP-2021-30 (130 Pages) are forwarded for your reference and Record. The said documents are also available at NEPRA website (www.nepra.org.pk).

Encl: As above

(Syed Safeer Hussain)
Registrar

CC:

Secretary Cabinet Division Government of Pakistan Cabinet Secretariat Constitution Avenue, Islamabad	Secretary Ministry of Energy (Power Division) 'A' Block, Pak Secretariat, Islamabad
Secretary Economic Affairs Division 'C' Block, Pak Secretariat, Islamabad	Secretary Ministry of Planning & Development 'P' Block, Pak Secretariat, Islamabad
Secretary Ministry of Privatization Privatization Commission Government of Pakistan 4th Floor, Kohsar Block, New Secretariat, Islamabad Tele: 051 – 920 7197	Secretary Water & Power Government of Gilgit Baltistan Near Kara Kuram International University, Gilgit Tele: 05811 – 920306

Figure 19: Project completion[36] Figure 20: Project anniversary[37]

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Community Investment Plan (CIP) and Corporate Social Responsibility (CSR)

The speaker praised the Community Investment Program (CIP), which has a budget of Rs. 655 million, to ensure that the benefits of the project are shared with the local community. He highlighted various facilities that have been developed including healthcare, drinking water, and educational facilities. Additionally, infrastructure improvements and recreational amenities have been implemented.

Figure 21: CIP Projects completed in Punjab[38]

[38] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

The speaker highlighted the successful initiatives in Punjab that have improved the welfare of the surrounding communities. These finished projects include the Government Boys Primary School in Kannad Karot and the Government Girls Primary School in Channi Awan Kahuta, the construction of a government dispensary at Brohi, Azad Pattan, a rest house at Beor, a Rural Water Supply Scheme at Kahuta's Brohi Area, building of the Tehsil Kahuta Area's access roads and the New Emergency Block (Trauma Center) at Tehsil Head Quarters Hospital Kahuta.

CIP Projects Completed in AJK

Figure 22: CIP Projects Completed in AJK[39]

[39] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

The speaker underscored the successful completion of Rehabilitation and Improvement of Basic Health Unit (BHU) Hollar (AJ&K) , construction of Government Boys Middle School Hollar (AJ&K), construction of Government Girls Middle School Hollar (AJ&K), Rehabilitation and Construction of Access Roads (Phase I and Phase II) Hollar AJ&K, the establishment of Public Park Hollar AJ&K, construction of Rest House at Hollar, upgradation of Educational Facilities District Sudhnoti, upgradation of Health Facilities District Sudhnouti, under the CIP initiative, to uplift the local community.

CSR Activity in the field of Education

Figure 23: CTG book corner at NUST[40]

[40] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

Figure 24: Scholarship for students[41]

Figure 25: MoU for NUST interns[42]

[41] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.
[42] Ibid.

Under the CSR initiative, fully financed scholarships were offered to students to pursue a four-year Bachelor of Electrical Engineering degree, with a special emphasis on students from project-affected areas. Ten of the 33 students who earned their BSc in Electrical Engineering degrees from Karot HPP were hired after they graduated. Furthermore, in December 2023, China Three Gorges South Asia Investment (CSAIL) and NUST signed a Memorandum of Agreement (MoA) to enable extensive cooperation. In September 2022, CSAIL also opened a "Chinese Book Corner" at NUST's Central Library, which was graced by CSAIL and NUST leaders.

Donations of Medical Supplies during COVID-19

The speaker noted the worthy donation ceremony was held in Beijing, China on April 21, 2020, to hand over tools and supplies to the National Disaster Management Authority (NDMA) of the Government of Pakistan at a second ceremony that took place in Islamabad.

Floods Donation to Pakistan in 2022

Figure 26: Donations related to Floods in Pakistan in 2022[43]

The speaker praised that project sponsors fully supported the Government of Pakistan during the devasting floods and provided donations for flood relief operations in Pakistan to the tune of around US$ 650,000.

[43] The figure in this section is extracted from the presentation of Mr. N.A. Zuberi during a national seminar on Pakistan's Energy Sector Issues, Challenges, and the Way Forward organized by the USPCAS-E and NIPS on May 16, 2024.

Corporate Awards

Figure 27: CTG corporate awards

Mr. Zuberi shared the accomplishments of Many KPCL Pakistani employees who were awarded the Pakistan excellent employee awards of the China-Pakistan Economic Corridor (CPEC) project during the past several years by the Chinese Embassy in Pakistan. Karot Project Camp won the 2018 China Overseas Project Excellent Camp Award. Karot Hydropower Project won the "2019 China International Sustainable Infrastructure Project Award", awarded by China International Contractors Association in December 2019 in Changsha, China, National Forum for Environment and Health) (NFEH)- CSR Awards Achievement during 2019 for Education and Health, NEPRA CSR STALWART Award Year 2022, NFEH CSR Awards in the Year 2019, the Year 2022 and Year 2023.

Key Challenges

The speaker highlighted the following challenges

i. **Lack of Integrated Coordination:** A lack of coherence among various agencies, such as the National Transmission and Despatch Company (NTDC), the Provincial Governments, the AJK (Azad Jammu and Kashmir) government, CPPA-G (Central Power Purchasing Agency Guarantee), and PPIB (Private Power and Infrastructure Board), results in inefficiencies and overlapping of responsibilities. This disjointed strategy makes it more difficult to coordinate and implement regulations effectively, which causes delays and bottlenecks in the electricity industry.

ii. **Frequent Policy Changes:** Power rules are regularly changed by both the federal and provincial governments, which erodes investor confidence and fosters instability in the business climate.
iii. **Bureaucratic Hurdles:** Different branches of the Pakistani government (GOP) are reluctant to act quickly. This frequently leads to departmental responsibility shifting, which catches problems in a bureaucratic trap.
iv. **Tariff Determination Delays:** Independent Power Producers (IPPs) suffer from NEPRA's tardy tariff determination processing.
v. **Circular Debt:** One major obstacle to the development of current and future hydropower projects is persistent circular debt.
vi. **Inter-Provincial and Trans-Boundary Issues:** Persistent disagreements and a lack of collaboration within provinces and across borders.
vii. **Lack of Provincial Ownership:** Projects started by the federal government are not owned by the provinces, and vice versa, which causes tensions and delays in progress.

Way Forward

Pakistan has a hydro Power potential of about 64,000 MW, however, so far only 11,000 MW has been developed. To tap vast hydropower potential a strategic approach involving all

stakeholders is essential. Following actions were suggested by the speaker for the development of Hydropower Projects.

i. **Government Commitment:** Having strong political will is essential to efficiently using hydro resources. This means that in order to maximize the potential of these resources, there must be explicit government policies that actively favor the growth of hydropower.
ii. **G to G and PPP:** Hydropower projects can be developed under both Government-to-Government and Public-Private Partnership modes, facilitating collaboration between public authorities and private sector entities to leverage resources, expertise, and investment for successful project execution.
iii. **Long-term Strategic Planning:** Pakistan's water resources and related infrastructure need to be developed into a sustainable development plan that spans thirty years. To guarantee the efficient use and management of hydro resources, this plan should include specific objectives, guidelines, and actions that will meet present and future energy demands while fostering environmental sustainability and economic expansion.
iv. **Collaborative Efforts:** All parties involved in the development of hydropower projects—WAPDA, the federal government, provincial governments, AJK, GB, CPPA-G, NTDC, PPIB, and the private sector—should pool their

knowledge and expertise. By integrating a variety of viewpoints and areas of expertise into the planning and execution stages, this collaborative method guarantees more effective and successful project outputs.

v. **Preparation of Documentation:** In order to draw in private sector investors and make project approvals and implementation easier, proper documentation needs to be provided well in advance.

vi. **Strengthening Institutions:** Hydropower-related institutions should be reinforced with skilled and knowledgeable personnel, backed by ongoing education and training. As a result, the industry will continue to develop sustainably and these institutions will be able to oversee and carry out hydroelectric projects with the necessary competence and capacity.

vii. **Improving Infrastructure:** Infrastructure, such as the network of transmission lines, highways, and other vital utilities, has to be greatly improved. Improving this infrastructure is necessary to ensure dependable energy delivery, access to remote project sites, and the effective construction and operation of hydroelectric projects.

Pictures of the Project Activities

6. Discussion

A vibrant and thorough discussion followed, with meaningful contributions from the experts and speakers.

During the discussion, one of the participants raised a concern regarding Pakistan's energy sector that faces a financial crisis due to systemic sector problems that affected the financial performance of energy utilities and hindered the effectiveness and sustainability of the energy sector. In this regard, the restructuring of the Water and Power Development Authority (WAPDA) entailed a process of unbundling, separating the institution into distinct entities focused on generation, transmission, and distribution of electricity. While the disaggregation has been achieved, the corporatization of these entities has not been followed by privatization as envisioned.

The speaker addressed the question by responding on Independent Power Producers (IPPs) with long-term contracts, while seemingly operational, presents a significant financial challenge for the government. The speaker further added that there are situations where IPPs make sense, although caretaker government previously recommended purchasing some existing plants, which would have resulted in a shorter payment period – 2-3 years instead of the current 7-8 years. Unfortunately, the high costs associated with IPPs, like HUBCO, demonstrate the limitations of this approach.

The speaker further added that the advice previously advocated for plant acquisition option seems less viable option now. Many older

plants, particularly those established pre-1994, are nearing retirement. Plants built under the 2002 and 2015 policies (a significant portion) will remain operational until 2025. This means the current challenges will persist for at least the next 15 years.

Another concern was raised by a participant was the issue of rising manufacturing costs in Pakistan. Patience alone won't solve this complex challenge, especially considering the current strain on industries like fertilizers and automobiles. While some improvement can be expected over time, a more proactive approach is necessary.

In respond to the question, the speaker emphasized that the crux of the problem lies in the lack of an equitable tax model. For the past decade, a significant portion of profits have flowed towards Independent Power Producers (IPPs), banks (many of which are foreign owned), and fertilizer companies. This profit concentration weakens the government's revenue base, hindering its ability to support crucial sectors like manufacturing.

To address this, policy revision is essential. The speaker stressed that there is need a tax system that ensures a fairer distribution of the financial burden and generates sufficient revenue to support strategic industries. This will require careful analysis and collaboration between policymakers and relevant stakeholders.

The participant raised a critical point regarding the lack of a clear roadmap for the future of mobility in Pakistan. One of the speakers,

while acknowledging the importance of this issue, highlighted some ongoing efforts. The Lahore University of Management Sciences (LUMS) Energy Institute has a dedicated mobility lab actively researching and assessing this sector. While progress may seem slow, their work is laying the groundwork for a more sustainable and efficient transportation system in Pakistan.

Another question by the participant tackled concerns regarding the potential privatization of the fertilizer sector. The participant expressed a concern that privatization, while introducing competition, could also lead to price deregulation, mentioning K-Electric as an example, where price controls exist despite privatization.

In response to the question, the speaker clarified the government's current efforts. In this regard the speaker mentioned, over the past two years, there has been a gradual increase in fertilizer prices, aiming to reduce the burden of massive subsidies. The long-term goal is to implement a market-based system. Under this system, the price of urea would be linked to import parity, with gas prices automatically adjusting to reflect market conditions. He further stressed that this approach aims to strike a balance between encouraging private sector participation and ensuring fertilizer affordability. While some price regulation might still be necessary, a market-based system has the potential to improve efficiency and transparency in the fertilizer sector.

Another participant raised concern about achieving a specific cost target (presumably 9 cents) The speaker while responding to the question said that in Pakistan, when industries would rely on imported raw materials, value addition within the country becomes crucial. This value addition translates to economic benefits. However, to achieve this, competitive electricity rates are essential. The specific electricity cost for value addition will depend on the energy consumption patterns of the individual industry.

7. Recommendations

1. Devolving Power for Effective Governance

To address the fragmented structure of the current energy sector, a restructuring is imperative. This involves strengthening regulatory bodies by equipping them with robust frameworks for data collection, analysis, and enforcement. Decentralization of power and increased accountability are crucial for efficient governance and decision-making within the energy sector.

2. Syndicated Energy Ministry

Establishing a unified Ministry of Energy by consolidating the separate Petroleum and Power divisions is essential. This centralized body should be staffed with a diverse team of experts including energy economists, geologists, strategists, lawyers, and financial specialists. Such a multidisciplinary approach will foster holistic decision-making and effective policy implementation.

3. Data-Driven Monitoring

To enhance transparency and project management, real-time dashboards with Gantt charts and critical path analyses should be developed for all gas, oil, and mineral exploration projects. This data-driven approach will enable close monitoring of project progress, from initial drilling to full operation, facilitating timely interventions and optimized resource allocation.

4. **Restructuring Support Agencies**

Revamping institutions like the Geological Survey of Pakistan, Hydrocarbon Development Institute of Pakistan, National Energy Efficiency and Conservation Authority, and Minerals Development Wing is crucial. These agencies should be empowered with enhanced capabilities in resource exploration, development, and efficiency promotion to effectively support the energy sector's goals.

5. **Privatization of Distribution Networks**

To introduce market competition and improve service delivery, the privatization of electricity transmission and distribution companies is recommended. This shift towards private ownership will encourage efficiency, innovation, and customer-centric approaches, ultimately leading to better service quality and financial sustainability.

6. **Unbundling SUI Companies**

To foster a competitive environment in the natural gas sector, the separation of transmission and distribution functions within Sui companies is necessary. Unbundling these operations will create opportunities for new market entrants and promote efficiency gains through specialized service providers.

7. **Open Market Access**

Encouraging private sector participation across all segments of the energy supply chain is vital. By allowing open market access, the government can stimulate investment, innovation, and competition, leading to improved energy affordability and reliability.

8. **Investment Incentives**

To boost domestic resource exploration, the government should revise policies and develop action plans to attract investment in gas, minerals, and coal exploration. Offering tax breaks, streamlining permitting processes, and guaranteeing fair market access will create a favourable investment climate.

9. **Roadmap for Clean Energy**

Developing comprehensive roadmaps for transitioning towards clean energy sources like hydrogen, solar power, electric vehicles, and green ammonia is essential. These roadmaps should outline clear targets, policies, and incentives to accelerate the adoption of renewable energy technologies and reduce reliance on fossil fuels.

10. **Capacity Building and Development**

To enhance the capabilities of the power sector workforce, comprehensive capacity building programs should be implemented. This includes Professional Development Programs (PDPs), Advanced Development Programs (ADPs), and

Continuous Professional Development (CPD) initiatives at all levels. Furthermore, the recruitment of competent leadership through headhunters for key positions like Managing Directors (MDs) and Deputy Managing Directors (DMDs) is essential for effective management.

11. Transforming SOEs and Demand Side Management

State-owned enterprises (SOEs) should undergo a transformation from a service model to a management model to improve efficiency and accountability. Simultaneously, focusing on demand side management is crucial. Additionally, facilitating industrial growth through an improved Ease of Doing Business environment will boost energy sales.

12. Tariff Reduction and Digitization

To alleviate the burden on consumers, tariff reduction measures should be implemented. This can be achieved through financial engineering techniques and adopting tailored Cost of Service methodologies for each consumer category. Concurrently, the digitization of Distribution Companies (DISCOs) is essential to enhance transparency, improve performance, and facilitate data-driven decision-making through the use of Key Performance Indicators (KPIs).

13. Transition to Carbon Neutrality and Integrated Resource Planning

The power sector must strategically evolve to align with the global shift towards carbon neutrality. Integrating renewable energy sources into the utility landscape is imperative. To effectively manage this transition, an Integrated Resource and System Planning framework should be implemented. Empowering an Independent System and Market Operator (ISMO) will facilitate efficient execution of this plan.

14. Market Development, Governance, and Structural Reform

Expediting the implementation of the Competitive Trading Bilateral Contracts Market (CTBCM) is crucial for enhancing market efficiency and competition. Establishing a National Energy Security Council (NESC) or National Energy Commission (NEC) with clear mandates and effective governance structures is vital for overall sector management. Addressing structural flaws in the Ministry of Energy to ensure procurement processes align with strategic planning is necessary. Finally, merging the National Electric Power Regulatory Authority (NEPRA) and Oil & Gas Regulatory Authority (OGRA) into a unified regulator can streamline governance and regulatory processes.

15. Strong Government Commitment

To effectively harness Pakistan's vast hydropower potential, a robust political will is imperative. This necessitates the formulation of explicit government policies that prioritize hydropower development. Such policies should create a conducive environment for investment, incentivize the sector, and provide necessary support for project implementation.

16. Public-Private Partnerships (PPPs)

Leveraging the strengths of both the public and private sectors is crucial for successful hydropower project execution. Adopting Government-to-Government (G2G) and Public-Private Partnership (PPP) models can facilitate collaboration, resource sharing, and knowledge exchange, leading to accelerated project development and improved efficiency.

17. Long-Term Strategic Planning

Developing a comprehensive, long-term strategic plan for Pakistan's water resources is essential for sustainable hydropower development. This plan should encompass a 30-year horizon, outlining clear objectives, guidelines, and action points for efficient water resource management and hydropower generation. Such a plan will ensure the optimal utilization of resources while considering environmental and economic factors.

18. Collaborative Approach

Fostering collaboration among all stakeholders involved in hydropower development is vital for project success. Bringing together WAPDA, government entities, provincial governments, autonomous regions, power utilities, and the private sector will create a synergy of expertise and resources. This collaborative approach will lead to more informed decision-making, efficient project execution, and optimal outcomes.

19. Institutional Strengthening and Infrastructure Development

Strengthening hydropower-related institutions with skilled personnel and continuous training is crucial for the sector's sustainable growth. These institutions will be better equipped to oversee and implement hydroelectric projects effectively. Additionally, improving infrastructure, including transmission lines and access roads, is essential for reliable power delivery and efficient project operations.

8. Moderator's Note

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Pakistan has oscillated between power deficit and surplus cycles repeatedly. Since the 1980s, Pakistan has grappled with substantial power shortages, notably impacting Karachi's industrial sector. Studies conducted by organizations like the Japan International Cooperation Agency (JICA) underscored the severe economic repercussions of load shedding during that era.

In the 1990s, faced with a 2,500 MW power shortage, Pakistan invited Independent Power Producers (IPPs) to invest in its energy

sector, resulting in an addition of over 7,000 MW of generation capacity. By 2001-2002, Pakistan had surpassed its power needs, even pursuing electricity export negotiations with India, which were halted due to political developments. Despite setbacks, the influx of IPPs continued, raising Pakistan's installed capacity to approximately 43,000 MW, exceeding its peak demand of 27,000-28,000 MW. Yet, managing this surplus presents its own array of challenges. Issues such as capacity payments to maintain unused capacity and circular debt—accumulated unpaid bills within the power supply chain—continue to strain the sector financially. Addressing these structural inefficiencies is crucial for ensuring a stable and sustainable power supply in Pakistan's future.

Looking forward, Pakistan must prioritize restructuring its energy policies to align supply with actual demand. This entails revisiting agreements with IPPs and implementing measures to enhance energy efficiency and grid reliability. By addressing these challenges, Pakistan can harness its energy potential to drive economic growth and stability, paving the way for a resilient and sustainable future.

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